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SCHOOL OF GRADUATE STUDIES DEPARTMENT OF CONSTRUCTION TECHNOLOGY AND MANAGEMENT

ASSESSMENT ON CONSTRUCTION EQUIPMENT MANAGEMENT PRACTICE IN ROAD CONSTRUCTION PROJECTS: CASE STUDY ON ADDIS ABABA CITY ROAD AUTHORITY

By

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APPROVAL PAGE

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DECLARATION

I, the under signed, declare that this thesis entitled "Assessment on Construction Equipment Management Practice in Road Construction Projects: Case Study on Addis Ababa City Road Authority", is my original work and has not been presented for a degree by any other person to the best of my knowledge, and that all sources of material used for the thesis have been duly acknowledged.

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CERTIFICATE

This is to certify that the thesis prepared by Mr. Michael Mulugeta entitled " Assessment on Construction Equipment Management Practice in Road Construction Projects: Case Study on Addis Ababa City Road Authority". And it is submitted as partial fulfilment for the requirement degree of masters of science in construction technology and management complies with the regulations of the university and meets the accepted standard concerning the originality, content, and quality.

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ABSTRACT

Construction equipment facility necessitates a substantial investment in construction industry. It is the major sector in the economies of both in developed and developing countries. Construction of huge and complex construction projects has required and requiring equipment. Large amounts of construction companies' capital are invested in equipment, and a variety of construction equipment has been used in construction. However, the deployment of equipment without management cannot increase productivity. This concept is lacking enough emphasis in road construction. Therefore, the aim of this study was to assess the construction equipment management practice in road construction projects in Addis Ababa city Road Authority (AACRA). Using random sampling technique, a total of 57 questionnaires were distributed. Descriptive and exploratory research designs was used in this study with the help of Statistical Package for Social Science (SPSS) and excel. For the description of the analysis, graphs and tables was used. Based on the results of the study, the organizations current practice is poor. Hiring and purchasing of equipment in the organization is not based on principle and requirement. The maintenance, upgrading and disposal of equipment is not based on statistical analysis of the equipment and the project. Equipment policy, equipment selection and equipment maintenance in the organization does not get enough emphasis. Equipment replacement and equipment benefit standardization is in random basis. Not enough standardization replacement analysis is made in the organization. Data record keeping of equipment is poor. The key success factors for equipment management does not get enough emphasis.

Keywords: Road construction, equipment, management, productivity

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LIST OF ACRONYMS

CE	Construction Equipment
CET	Construction Equipment Technicians
CEM	Construction Equipment's Management
AACRA	Addis Ababa City Road Authority
PPM	Planned Preventive Maintenance
PCM	Planned corrective maintenance

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CHAPTER ONE

1. INTRODUCTION

1.1. Background

Construction equipment facilities necessitates a substantial investment in construction industry. It is the major sector in the economies of both in developed and developing countries. In many countries of the world the portion of construction sector accounts for more than 10% of the growth of domestic product. Construction of huge and complex construction projects has required and requiring equipment. Large amounts of construction companies' capital are invested in equipment, and a variety of construction equipment has been used in construction (Yeo & Ning, 2006).

Equipment in construction projects plays an important role in construction development. Yet the management of construction equipment phases many challenges. Due to this, project schedule slips, budget overruns, compromised quality, resulting claims and counter-claim happened. Previous researches have dealt much with the problems of equipment management. However, sustainable solution is not developed (Gransberg et al., 2006).

According to the study made by (Khot & Patil, 2020), construction equipment costs 5% to 10% of the direct cost incurred in building construction. It reaches 40% of the direct costs incurred in road construction. In this construction equipment was considered as outstanding important in road construction. Though, construction equipment is covering high percent of direct cost in road construction industry, management of construction equipment does not get emphasis yet.

Road construction is one of the extensive equipment demanding construction sector throughout the world. It relies primarily on high utilization of machinery. Thus, for road contractor equipment is one of the key factors for improving their capability in performing the work more effectively and efficiently. However, in many construction companies the management of construction equipment is not getting enough emphasis (Shen et al., 2017).

The management of equipment affects the productivity of once company. This includes the management of equipment from inquiring to disposal. To inquire an equipment, the productivity

capacity, the cost, the skill of the operator available, the number of equipment to be purchased and the capacity of the company to purchase should be studied first. This management system is necessary also up to disposal of equipment. This principle agrees with the idea that good project management in construction must vigorously pursue the efficient utilization of labor, material and equipment (Azmi & Danish, 2017).

Construction projects are highly mechanized now a days and becoming more quantity every day. One of the important resources in the field of construction process is the equipment for the construction companies. Therefore, Equipment is said to be one of the key factors for improving contractor's capability in performing their work more effectively and efficiently. By strengthen or upgrading the effectiveness of utilizing equipment large volume of work can be completed within a shorter span and more importantly, within the project schedule time. With the growing industrialization of construction projects, the role of onsite equipment and machineries is absolutely necessary in achieving productivity and efficiency. During construction selection of justified equipment has always been a key factor in the success of any construction work. This decision is typically made by matching equipment in a fleet with tasks. Such matching accounts for equipment productivity, equipment capacity, and cost (Azmi & Danish, 2017).Therefore, in this research, Assessment was made on construction equipment management practice of road construction projects in Addis Ababa city Road Authority.

1.2. Statement of the problem

As clarified above, the concept of construction equipment management is a crucial component of road construction management practices. As crucial as it is, however, this sector of management does not get the required attention. Not only in the areas of road construction companies resource management, but also in other specific components of road construction equipment aspects like, acquiring, planning, selecting, procuring, operating, maintain, replacement and disposal. Many researchers have been observed being ignorant of the significance of adequate level of Construction Equipment Management in road construction.

Road construction demands many resources like labor, material and equipment. Equipment is the productivity determinant in construction industry. Even though, the management system of road construction is not getting enough management. Because of low management system the

development of road construction, the quality of road, the satisfaction of customers and sustainability of road construction is not achieving.

Despite the fact that Ethiopia is currently involved in wider construction activity, the concept of road construction equipment management, in most cases, has been left of the minds of contractors in their project designing. This significantly affect the effectiveness of the road construction companies and the problem appeared to persistently contaminate the whole process of road construction. This is difficult to waiting the scarce resources of the nation for mismanagement of available road construction equipment would definitely affect values of time, quality, safety and efficiency of construction companies.

Productivity and equipment are dependent if properly managed. Currently technology is demanding the deployment of equipment in many constructions works to increase productivity. However, the deployment of equipment without management cannot increase productivity. This concept is lacking enough emphasis in road construction. Road construction companies employs many equipment but no improvement in their management. Therefore, the aim of this study is Assessment on construction equipment management practice in road construction projects in Addis Ababa city Road Authority.

1.3. Objectives

1.3.1. General Objective

The general objective of this study is to assess the construction equipment management practice in road construction projects in Addis Ababa city Road Authority.

1.3.2. Specific Objectives

1, To assess the current practice of construction equipment management practice in road construction projects in Addis Ababa city Road Authority.

2, To study the factors that affect equipment management practice in road construction projects in Addis Ababa city Road Authority.

3, To recommend best practice of construction equipment management for road construction projects in Addis Ababa city Road Authority.

1.4. Research Questions

1, What are the current practices of construction equipment management in road construction projects in Addis Ababa city Road Authority?

2, What factors can affect equipment management practice in road construction projects in Addis Ababa city Road Authority?

3, How can best practice of construction equipment management have suggested for road construction projects in Addis Ababa city Road Authority?

1.5. Significance of the Research

The research will benefit all stakeholders and academicians by providing useful information about road construction equipment management and issues related to its practice. It will also be useful for Addis Ababa City Road Authority by providing information about the theoretical and challenges of practicing road construction equipment management. The research will also be used as an initiation for those who are interested to conduct a detailed and comprehensive study regarding the practice of road construction equipment in Addis Ababa and Ethiopia as whole. And it will help the governing body, specifically the higher responsible body, and the managements of Addis Ababa City Authority to be aware of the perceived and actual practices of road construction equipment management and give insight on how to adopt the different aspects of road construction equipment management most effectively and efficiently. It will be also very important for future research in academic purpose by indicating information in regard to different aspects of road construction equipment management.

1.6. Scope and Limitation of the Research

1.6.1. Scope of the research

The scope of this research is limited to the road projects operating under Addis Ababa City Authority in Addis Ababa. The area of construction equipment is wide area of study. However, in this research practice of construction equipment in Addis Ababa City Road Authority have been scoped.

1.6.2. Limitation of the research

Despite making every attempt to gather the necessary inputs as main and secondary data with clear process, analysis and technical interpretations, the study nevertheless has the following limitations.:

- Due to the time constraint, the study addresses on road projects that are constructed with a private construction firms in Addis Ababa City Road Authority.
- The research solely examined current practices, factors that affect construction Equipment management in Addis Ababa City Road Authority.
- The study's main area of interest is limited on recommendation of improved construction equipment management practice rather than model development due to time restriction.

1.7. Organization of the study

The general outline of this thesis report is as follows: -

Introduction: - This chapter has introduced the core issues to be addressed in construction equipment management. It gives a broad background to the subject matter, presents the problem statement and propositions, research question, articulates the objectives and justifications for construction equipment management, and puts forward the scope and the limitations of construction equipment management.

Literature review: - (detailed and contextual): - This chapter, while intricately related to chapter two, presented the context of construction equipment management. It develops the conceptualizations in chapter two into analysis and understandings of the Concepts, principles as well as best practices associated with the major issues of construction equipment management. It presents the literature foundation for the research instrument as well as the "best practices" reference base for the analysis and interpretation chapter.

Methodology: The chapter systematically formulates the research methodologies and techniques employed for the study. It provides a description of the methodologies and approaches employed. Within this framework, the chapter stereotypes the cases selected, the data sources used and the data analysis techniques employed.

Analysis and interpretation: The chapter analyses and interprets the data collected and compares the findings with comparable "international accepted practices" and theoretical justifications. It presents descriptions of the construction equipment management and their management as practiced by the targeted subject. The chapter also presents analysis and critique of the practices as compared with theories and international practices and suggestions of better practice based on the gathered data.

Conclusion and recommendations: The chapter, in light of presenting major findings of the study the conclusion. It also presents recommendations for future study.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Introduction

This literature review is lines down the fundamental concepts and principles related to the objective of the research to find out the gaps and limitations in the body of knowledge of road construction equipment management. The study focused on "assessment on construction equipment management practice in road construction projects in Addis Ababa city Road Authority". Therefore, the literature review accommodates elements of road equipment management and is mainly focusing on the core concepts of equipment management from planning to disposal of road construction equipment. In addition to these, views of experts in areas of record keeping and use computers practices, standardization, economics of construction equipment, previous studies on road construction equipment management in some other countries, and studies of construction equipment in Ethiopia have been included.

2.2. Construction Equipment and Construction Equipment Management

2.2.1. Construction Equipment

The science of construction equipment has been a point of research for a long period of time. In its border sense, however, many researchers in the field agree that construction equipment, as a construction terminology, refers to all kinds of machinery that are utilized to assist human labor in the field of construction sites። Equipment is said to be one of the key factors for improving contractor's capability in performing their work more effectively and efficiently. By strengthen or upgrading the effectiveness of utilizing equipment large volume of work can be completed within a shorter span and more importantly, within the project schedule time (Parveen & Khan, 2018).

Studying construction equipment is crucial and vital because the share of equipment cost is very significant in construction project. It is also one of the resource areas in construction that can generate profit if it is utilized efficiently and effectively. In addition to this, it should be arguments in the contemporary engineering development to have a closer look at construction equipment because the extent of mechanization in the new technology engineering contexts

appears to be mandatory. According to him, the extent of mechanization determines the cost of a project in terms of cost of construction equipment (Edwards & Holt, 2009).

2.2.2. Management process of construction equipment

Every construction companies should have policies and processes on equipment control & asset management. Equipment control and asset management involves the management of construction equipment within a company. Equipment control begins with the receipt of a newly acquired equipment item and continues through the item's entire life-cycle. Newly acquired equipment should be inspected by in-house or contracted construction equipment Technicians (CETs), who will receive an established equipment control/asset number from the Equipment/Property Manager. The control method can be used to track and record maintenance activities in the database. Once an equipment control number is established, the device is safety inspected and readied for delivery to project areas in the company (*Construction Equipments & Classification Content*, 2002).

(Rafsanjani et al., 2009) emphasis that CEM is a process, which includes that planning, selection acquisition, productivity, maintenance, standardization and quality control cycles. In many cases, however, most of the aspects of this process are either neglected or skipped over. According to researcher's observation, despite the fact that CE is owned and managed by professionals", in frequent occasions managerial process seems to follow traditional CEM practices then scientific conventional approaches.

According to (Alkass & Harris, 1989), points out that, the "equipment managers main task is to reduce downtime of CE and achieve optimum CE utilization and increase productivity at minimum cost". He also reiterates that "proper planning, selection, procurement, installation operation, maintenance, and replacement "process need to be policy driven an, "have important role in CEM".

Generally, an equipment manager is responsible of acquiring the equipment, where as it is the responsibility of the construction planning group to select equipment. Nevertheless, both the inventory of equipment in hand and the standard equipment policy play an important role in equipment selection. Therefore, final decision on the equipment required for the projects is generally given by equipment managers, project managers, and construction planning group

together. Often, the decision-making process can create tensions in the enterprise. Once the selection of equipment is made, a choice has to be made whether to buy, rent, or lease it. These decisions are given based on the economic standing and strategy of the firm, and the nature and frequency of equipment use (Sjodin et al., 2016).

In operations and maintenance of construction equipment stage, the equipment in use should be maintained properly, by scheduling preventive maintenance periods. Scheduled maintenance reduces the incidents of failure, and thus minimizes costly breakdowns and stoppages on the project site. In construction industry, preventive maintenance has increased the efficiency level of the industry around 10-20%, by reducing the break-down time of the equipment (Harris & Bailit, 1988). For high utilization rates, the equipment should be kept in a good condition. Also, proper selection and training of operators and maintenance personnel is part of the responsibility of the equipment manager. In addition, safety of both the operators and the equipment should be considered and properly managed. Furthermore, proper registration and inventory records are part of the inventory process. Besides the equipment life cycle, equipment managers are also responsible or operating the equipment maintenance and storage facilities.

2.3. Equipment Management Practices in Construction Companies

The cost of equipment in a project varies from 10 to 30% of the total cost of the project, depending upon the extent of mechanization. In modern fully mechanized projects, the cost of equipment goes up to 30%. Proper planning, selection, procurement, installation, operation, maintenance and equipment replacement policy plays an important role in equipment management for the successful completion of the project. With the growing use of machinery, it has become necessary for construction engineers to be thoroughly familiar with the construction application and upkeep of the wide range of the modern equipment (Lima et al., 2017).

According to the work performed by (Narang, 2013) equipment manager's main task is to reduce downtime, achieve optimum equipment utilization and increase production at minimum cost. The cost analysis and the will of adopting proper techniques suited to the situation are the basic factors for the success and therefore, there is a need for a rational planning, proper selection, and judicious deployment of equipment in relation to the conditions so as to achieve optimum utilization. Equipment engineer should coordinate with various wings of the organization in

discharging his job of equipment planning, balancing, selection of equipment and its utilization, personnel selection and training, financial planning, preventive maintenance and general supervision. Thus, equipment management integrates and continuously interacts with human, technical, financial and production system in order to achieve top efficiency and cost effectiveness.

According (Ahren, 2011), Construction equipment management is concerned with the purchase, retirement, replacement, operations, logistics, an maintenance of equipment. The objective of the firm is to minimize maintenance, and repair costs, while achieve high utilization of the construction equipment. These responsibilities could be categorized into two groups: operational and strategic responsibilities could be categorized into two groups: operational and strategic responsibilities. Operational responsibilities consist of day-to-day management of construction equipment. Generally, these decisions are given by project managers, who are assigned to specific equipment for specific time by the equipment managers of the firm.

In most of the construction firms, equipment managers are the sole under takers of the overall responsibility of equipment management. Based on their experience, equipment managers decide on the day-to-day management of equipment operations, and also on strategic operations such as new equipment procurement. Thus, responsibilities of the equipment managers, ensuring that the equipment is properly used, maintained, utilized and managed, are rather challenging. Effective operation of construction equipment should be maintained to avoid underutilization of such large capital investment. Also, preventive maintenance and repair should be carefully planned, and high productivity rates should be realized during operations. As the equipment fleet gets larger, maintaining such goals become a big challenge (Ohkawa, 2000).

2.3.1. Planning Construction Equipment

Equipment planning on major construction projects includes besides its selection, the decision about working shifts, number and size of machines, the matching of units working in a team, procurement schedule and the arrangement of necessary technical staff to operate, service and repair of the equipment. Planning of workshop and store facilities is also an important aspect of equipment planning (Yeo & Ning, 2006).

Even though this part of the process of construction equipment management can be accumulated in the acquisition phase, it is such an important part of the process for it determines the basic structure of a project at hand. According to (Azmi & Danish, 2017), planning Should be, ”done with great care, as the efficiency of the whole project largely depends up on its planning” If construction equipment costs up to 30% the total cost of a project , it is very important to exert maximum effort on the planning of equipment.

Planning is an important step, had many points worth according (Sjodin et al., 2016), equipment the worth of ordering of the extent of mechanization, equipment planning and execution planning and making decisions accordingly.

With regard to the extent of mechanization that (Organisation, 2015), identified four important factors. The first one is the availability of manpower. Especially Sharma state, that the availability of cheap labor for adduction of a project may not force the equipment manager to involve in equipment investment, where as expensive managers could lead to investing heavily on equipment. The second factors that determine the map of planning for CE is completion period, some would like to put it, project life. Completion period plays a desire role about the extent of mechanization because less completion period entails less mechanization”. This means the longer the life of the project, the better the chance of the project managers to depend on human labor, and the shorter the life of the project, the higher the chance of the manager to depend on CE.

The third factors to consider are the nature of the work to be accomplished by the project. At times, (Prajeesh & Sakthivel, 2016), it is difficult to carry out the project without the use of CE for the work is beyond the scope of human labor to perform.

2.3.2. Selection of Construction Equipment

Based on the study performed by (Prajeesh & Sakthivel, 2016) selection of Construction equipment for a construction project is one of the major functions and decision-making processes carried out by the construction company planning the construction of the project. This is due to the key role in the success of the project played by the selection of the appropriate equipment. Simple, “regular” projects, especially if similar to projects the company has previously built, may not pose a challenge in terms of equipment selection; however, when the project is no

longer “regular and definitely in the case of complex and large-scale projects, equipment selection also becomes very complex and challenging. This is due mainly to the following reasons, which should also serve as general guidelines for conducting the selection process:

- A great variety of makes and models is available for each type of equipment which, by itself, generates a great number of alternatives.
- Construction companies commonly build several projects concurrently, each requiring its own Equipment planning, and individual equipment plans that look into utilizing equipment owned by the company must be in concert with each other.
- Feasible equipment alternatives are primarily evaluated and compared on the basis of costs; however, a great many qualitative and intangible factors that are difficult or impossible to quantize must be considered systematically to ensure the selection of a “good” alternative.

Proper selection of equipment for a construction project is vital importance for its speedy and economical completion. Problem of equipment selection has become more complicated, because large varieties of equipment are being manufactured now-a-days. For proper selection of equipment, a considerable experience in the operation and maintenance in the field is essential. Records kept for operation, maintenance and actual output obtained under comparable conditions of previous projects will greatly help in taking decision for equipment selection (Ahren, 2011). According to him, the Following are the main points which should be considered in the process of equipment selection.

- Suitability for job conditions. The equipment must meet the requirement of the work, climate and working conditions.
- Size of the equipment. Size of equipment should be such that it must be able to be used with other matching units.
- Standardization. It is better to have same type and size of equipment’s in the project. It means lesser spare parts reserve, more interchangeability of parts if required, easy for the operators to understand it mechanics will be able to maintain and repair better as they become expert by handling similar type of equipment.
- Availability of equipment. The equipment which is easily available in the market should be purchased. It should also be ensured that the equipment is of repute and is likely to be

continued to be manufactured in future also. This is necessary for future standardization and ensuring spare parts supply. It is easy to dispose of such equipment after completion of project.

- Availability of spare parts. While selecting a particular type we should be ensured that the spare parts will be available at reasonable price throughout the working life of the equipment. It should also be ensured that the downtime of the equipment for want of spare parts may not be more.
- The economic aspects. While selecting the equipment, it should be considered that the unit cost of production should be as least as possible.
- Reliability of the equipment. Equipment selected for the project must be reliable one.
- Service support. Service support should be available in the area of project where the equipment shall be used. Service after sales is a major criterion for selection of equipment.
- Operating requirements. The equipment selected should be easy to operate and maintain, acceptable to the operator and should have lesser fuel consumption.
- Past performance. If the equipment being purchased is of new make and model, it is desirable to enquire about its performance from other users, who are using this make and model.

(Rafsanjani et al., 2009), suggest that there are several quantitative evaluation techniques to select the most economical equipment from different alternatives viable in the market. The basic retrain, however, is that there is a demand for a particular type of equipment in the hire market or the machine is simply melded for construction work undertaken by the company needed for construction has been made by the top management to purchase a particular type of equipment the next step should be to carry out an economic evaluation using techniques. Such as payback period method, Accounting return on investment, Internal of return, Next present worth method (or equivalent annual cost method). These techniques use the anticipated cost or both revenues and cost of different equipment alternative in the analysis.

2.3.3. Construction Equipment Purchase

Once the selection of equipment is done the purchase action for the selected model and type is started considering lead time for the supply of equipment, time required for its installation and

commissioning, and the time when equipment should be available for use. The process of selection of equipment is generally a part of procurement, followed by equipment planning and helps in purchase of equipment. The complete procurement action is divided in various activities like calling enquiries, its technical and financial evaluation, ordering, contract-making transporting, assembling, installation and commissioning, and should be followed vigorously, as any delay in any of these activities will result in delay in completion of the project. Therefore, these activities are monitored at top most priority (Razali & Manaf, 2014). Generally, fast moving or maintenance spares are purchased along with the equipment especially for a period of one or two years. Equipment should be purchased in phases, so that the money is not blocked and equipment required later do not remain idle.

Purchase of new or used equipment obviously involves large amount of capital. The options available for financing equipment can be given as (Oloke et al., 2001): state through outright purchase, hire purchase, leasing using a finance laces, credit sale or trade or trade credits. The outright purchase uses funds from retained profits, or from a bank loan which may be either on a short-term basis (bank overdraft) or on a long-term basis. Under this type of financing the purchaser acquires the title to the machine and the tax benefits. Also, the owner could deduct interest on his equipment loan if they had taken such a loan.

(Oloke et al., 2001), advice Contractors and other users of construction equipment are required to take a decision as to whether to purchase equipment or to acquire it on hire. The purchase or acquire through hire of equipment decision attempt to take into account the following issues.

- When the equipment used for the most of the construction period and likely to complete almost its full life, while working in the project.
- It remains available for use whenever it is needed.
- Purchased equipment means an own equipment, is generally kept in better mechanical condition and is more reliable. This means matching equipment will not be affected adversely due to frequent breakdowns.

Beside the followings are also issues to be considered while owning the equipment.

- When the equipment cannot be used for its full life, then the owning may be more expensive than hiring.

- The purchaser is required to do huge investment initially, which otherwise he may need for other purposes.
- Contractor may have to face the danger of obsolescence of the equipment.

In this system user hire the equipment at the prevailing rate with a provision that the organization may purchase it at a later date if it wishes to do so. In case it decides to purchase the equipment, a specified portion (generally about 80%) of the hire charges paid shall be adjusted against the original purchase price of the equipment. An agreement, specifying the percentage of hire charges to be adjusted along with other terms and conditions, is made between both the parties. The specified portion allows the previous owner of the equipment to cater for the interest, insurance, taxes (Rafsanjani et al., 2009).

2.3.4. Operation and Utilization of Construction Equipment Management

Since this is the task directly responsible for utilization, maximum managerial care should be given to the „operation. ‟ Following are an important responsibility for asset managers is to ensure that maximum benefit is derived from their assets. Accordingly, asset managers need to be mindful where, for example, equipment is no longer effective in performing the activities required of it, it is in less than optimum condition, or demand for the services it delivers or supports has reduced (Khot & Patil, 2020). Underutilized equipment should be identified and the reasons for this examined and, as far as Possible, rectified. The utilization of major equipment items is not monitored on a regular basis. In general, information on equipment utilization is only communicated to hospital management annually when considering equipment replacements and is only confined to those items that were deemed to need replacement. As a result, any potential problems arising from underutilized equipment may not be known by company management.

2.3.5. Equipment Maintenance Practices

Every machine is thoroughly tested and inspected by the manufacturers before selling. When it is used, it is subjected to wear and tear and hence appropriate and undue attention should be given to protect the machine and its components from undue wear and thus protect them from failures. A proper attention means lubrication, cleaning, timely inspection and systematic maintenance. Maintenance means efforts directed towards the up keep and the repair of that machine. Repair must be done at a time when it may have least disruptions i.e. machine may be repaired when it is not being used or its use may be postponed without affecting the production much. Thus,

maintenance is responsible for the smooth and efficient working of an industry and helps in improving the productivity. It also helps in keeping the machine in a state of maximum efficiency and economy (Sjodin et al., 2016).

According to (Rafsanjani et al., 2009), equipment maintenance is a science because it involves scientific and technical knowhow of different machineries involved, and it is an 37 art because for identical problem it may require different treatment or action or process. We need equipment for technical and speedy construction and at the same time for economical and timely completion of project.

According to (Alkass & Harris, 1989), Maintenance, being an important support function in businesses with significant investments in plants and machinery, plays an important role in meeting this tall order. Consequently, the equipment management has passed through significant changes in the recent times. In the present manufacturing scenario, the maintenance function has become an integral part of the overall profitability of an organization. Every machine is thoroughly tested and inspected by the manufacturers before selling. When used it is subjected to wear and tear, hence proper attention should be given to protect the machine and its components from undue wear and thus protect them from failures. A proper attention means lubrication, cleaning, timely inspection and systematic maintenance. Maintenance means efforts directed towards the up keep and the repair of that machine.

The main purpose of maintenance is to keep the equipment in good, serviceable condition. Therefore, equipment maintenance is a vital function in any contracting or plant hire company. This function includes all the activities such as daily and periodic inspection, lubrication, servicing, repairs and periodic overhauls. The basic form of maintenance as pointed out by (Rafsanjani et al., 2009), Planned preventive maintenance (PPM),

- Planned corrective maintenance (PCM),
- Unscheduled or unplanned maintenance inducing repairs or break down maintenances

2.3.6. Construction Equipment Replacement

Equipment replacement decision plays an important role in the economic running of any concern for years. The reasons for replacement of equipment are: deterioration, obsolescence and inadequacy. The equipment is replaced in order to reduce production cost, to reduce fatigue, to

raise quality, to increase output, to secure greater convenience, safety and reliability. The capital needed for the replacement of the equipment is recovered during its life cycle through depreciation realized every year (Oloke et al., 2001).

2.3.7. Equipment Disposal

According to (Razali & Manaf, 2014), when equipment becomes obsolete, is not suitable for use for a variety of reasons (damaged, can be used but parts need to be replaced, making it cheaper to buy new equipment, etc.) or is surplus to requirements, there should be a way to dispose of it. Where possible, recycle equipment by giving it to other organizations or individuals in the community who can make use of it as long as it is safe to do so; otherwise it must be destroyed. The recipient must be informed of what needs to be carried with the equipment (e.g. replace a part) before it can be used again, if such action is required before use. Equipment marked for disposal can also be used as a source of spare parts. For equipment that cannot be repaired and reused, such as slings and slide sheets, a disposal system is needed. Such equipment should be disposed of as recommended by the manufacturers.

2.4. Summary of research gaps

Construction activity, and the concept of road construction equipment management, in most cases, has been left of the minds of contractors in their project designing. This significantly affected the effectiveness of the road construction companies and the problem appeared to persistently contaminate the whole process of road construction. This is difficult to waiting the scarce resources of the nation for mismanagement of available road construction equipment would definitely affect values of time, quality, safety and efficiency of construction companies.

Productivity and equipment are dependent if properly managed. Currently technology is demanding the deployment of equipment in many constructions works, to increase productivity. However, the deployment of equipment without management cannot increase productivity. This concept is lacking enough emphasis in road construction. Road construction companies employs many equipment but no improvement in their management.

CHAPTER THREE

3. RESEARCH DESIGN AND METHODOLOGY

3.1. Study Area

The research was conducted in Addis Ababa City Road Authority.

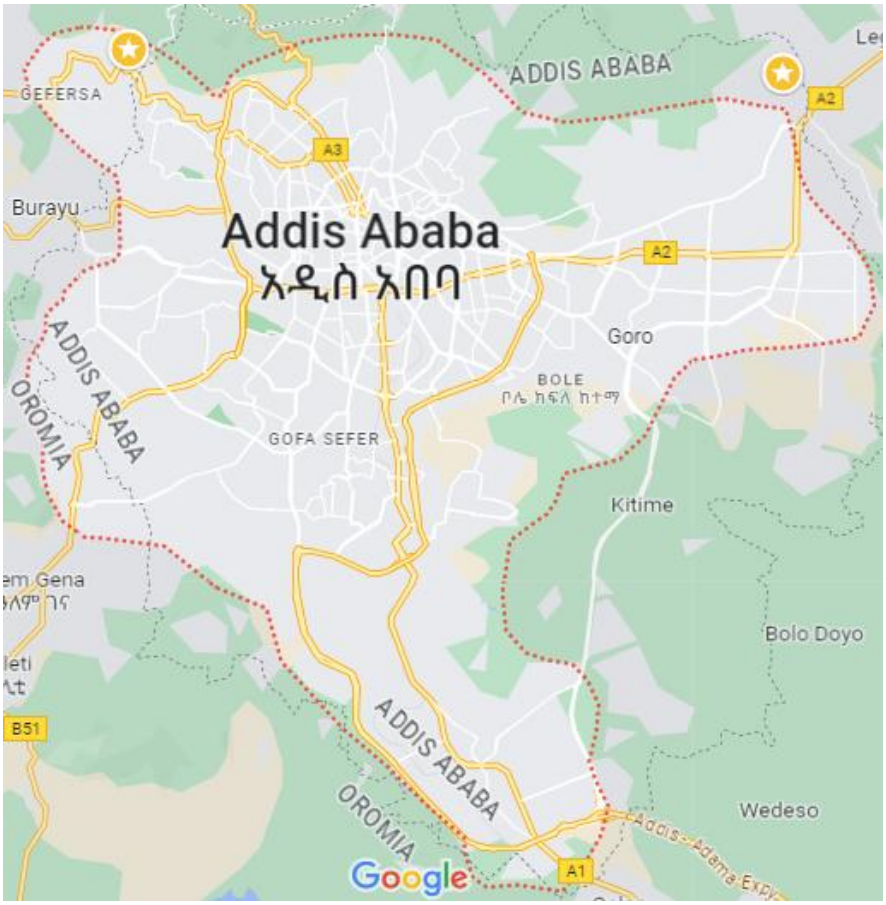

Figure 3.1 Map of Addis Ababa City

3.2. Research Designs

Descriptive and exploratory research designs were used in this study. The exploratory type concerned on gaining idea and insight about the management of construction equipment in Addis Ababa City Road Authority. And the descriptive type describes the extent of practices of construction equipment management in Addis Ababa City Road Authority. The research was conducted through structured questionnaires and interviews.

3.3. Research Population

The population for this research was the road projects under Addis Ababa City Road Authority (AACRA). Currently, AACRA has four (4) lots and one specific project called rental group. The numbers of projects under each lot are as shown in Table 3.1 below:

Table 3.1 Research population

No.	Project Name	Number of projects
1	Lot-1	6
2	Lot-2	9
3	Lot-3	6
4	Lot-4	7
5	Maintenance-1	85
6	Maintenance-2	35
7	Total	148

3.4. Sample size

The required sample size for the research for each party involved in the survey was determined statistically using the following expression.

- ✓ $no=p*q/v^2$ …….... [Eq. 3.1]
- ✓ $n= no / [1+ (no /N)]$ ……. [Eq. 3.2]

Where:

- no: First estimate of sample size
- p: The proportion of the characteristic being measured in the target population
- q: Complement of p or 1-p
- v: The maximum standard error allowed (0.1 for our case)
- N: The population size

▪ n: The sample size

To maximize, p will be set at 0.5. To account for possible error in the respondent answers from the questionnaire, the maximum standard error will set at 10% or 0.1.

Lot	q	p	v	N	no	n
1	0.5	0.5	0.1	5	25	5
2	0.5	0.5	0.1	8	25	7
3	0.5	0.5	0.1	5	25	5
4	0.5	0.5	0.1	6	25	5
5	0.5	0.5	0.1	85	25	20
6	0.5	0.5	0.1	35	25	15

3.5. Sampling Technique

Since the population and sample size of the research are too large to cover all, only some of them are investigated. Therefore, for this study purposive sampling method was used. Here, only importantly selected road projects will be investigated.

3.6. Data collection processes

The research was conducted through the collection of data using structured questionnaire and interview survey approach for the Addis Ababa City Road Authority.

3.6.1. Questionnaire approach

Section one: in the first section, back ground information of respondents including gender of respondent, organization of respondent, job position of respondents, and educational background of respondents.

Section two: in this second section, structured questionnaire was used to evaluate the practices of the road projects, factors affecting management of construction equipment and ways of improving management of construction equipment under Addis Ababa City Road Authority.

3.6.2. Interview approach

In this sub section, supplementary questions that strengthen the survey data proposed in the questionnaire were developed in a structured way.

3.7. Steps of conducting this research

1. Literatures are reviewed

Literature was reviewed and a questionnaire variable was identified. On the process of literature review, it was assessed the back ground of construction equipment, management process of construction process and economics of construction equipment.

2. Design of questionnaires and interviews

Structured questionnaires and interviews were designed in a way to achieve the research objectives. Copies of these questionnaires and interviews were attached in the appendix part of this paper.

3. Distribution of questionnaires

The data for this research was collected by distributing a formulated structured questionnaire and interviews was asked in a structured way.

4. Analyze the responses from questionnaires and interviews

The data that was collected from questionnaires and interview was analyzed both qualitatively and quantitatively. Tables and graphs were employed for elaborating and discussing the data.

5. Conclusion and Recommendation

After the analysis made, Conclusion was drawn from the bases of the analysis and recommendation was forwarded to the user of this research regarding to management practices of construction equipment.

3.8. Method of Data analyses and Presentation

The data collected from questionnaire and interview was analyzed. Graphs and tables were used to analyze, discuss and interpret the research data. To analyze research data frequency

distribution, RII method (weighted mean score) using excel was used. To strengthen the research data of the study case study have been used.

3.9. Validity and Reliability Test

3.9.1. Validity

Validity is a term used to evaluate the accuracy and quality of research. It is related to how a method; a technique and tests of a research are accurate. To increase the validity of the research, the researcher was undertaking the following conditions:

- Data was collected using standardized interview and questionnaire.
- Sample questionnaire was distributed and collected by the researcher carefully
- A pilot test by experienced professionals with an experience of more than 25 years in road construction areas on those who are working around the case study have been conducted. Through having comments from those professionals, the validity of questions have been confirmed.

3.9.2. Reliability

Reliability is a consistency of a measurement. It has to do with the accuracy and precision of a measurement procedure. The questionnaire was pre-tested with few employees to test the content of the instrument and also to check the clarity, ambiguity structure and length before the final distribution of the questionnaire.

Reliability Statistics	
Cronbach's Alpha	N of Items
.977	10

3.10. Ethical consideration

The researcher treats all the information given by respondents kept confidentially without disclosing the respondents' identity and respect the valuable relationship among them. Furthermore, the questionnaire was distributed only to voluntary participants and interviews will be asked to voluntary participants. Lastly, all secondary quoted to keep the right of ownership of all materials.

CHAPTER FOUR

4. DATA ANALYSIS AND DISCUSSION

4.1. Introduction

This chapter deals with the presentation and analysis of data gathered from respondents and secondary sources in Addis Ababa City Road Authority. As it was proposed, questionnaires, interviews and observations were used to collect data from the respondent's in line with secondary sources. The analysis is done by breaking in to sections for the ease of analysis. Regarding to the presentation and data analysis, graphs, tables, numbers, percentages and chi-square test were used.

Table 3.2 Questionnaire response rate

Questionnaires distributed	Questionnaires returned	Questionnaires retrieved	Questionnaires Not returned	Questionnaires Valid
57	52	49	5	3
100%	91%	86%	9%	5%

4.2. Background information of respondents

The demographic characteristics of the respondents play a very significant role on their decision and analyze to fill the survey data. This part comprises gender, organization, job position, educational level (background), and work experience of the respondents.

Gender of Respondent

According to the survey data indicated in Table 4.1 below, from the total 49 respondents 35 (71.4%) were males and the remaining 14 (28.6%) were female respondents. On the other side, the majority of the respondents 39 (79.6) %) were from the client (owner) of the organization, while the remaining 10 (20.4%) were from the rental (external contractor). Based on the survey data, above 50% of the respondents were site engineers and office engineers. This accounts 29 (59.2%) out of the 49 respondents. The remaining 12 (24.5%) and 8 (16.3%) were team leader and manager respectively. From this it can be understand that the respondents had enough

information about their organization and therefore can provide consistent data for the study in response to the distributed surveying questionnaire.

Table 4.1 Background information of respondent (Gender, Organization, job position, educational background and years of experience)

Gender	Frequency	Percent
Male	35	71.4%
Female	14	28.6%
Total	49	100.0%
Your organization	Frequency	Percent
Client (Owner)	39	79.6%
External Contractor (Rental)	10	20.4%
Other, please specify	0	0.0%
Total	49	100.0%
Job Position	Frequency	Percent
Manager	8	16.3%
Team Leader	12	24.5%
site Engineer or Office Engineer	29	59.2%
Total	49	100.0%
Educational background	Frequency	Percent
≤ Diploma	0	0.0%
BSc/BA degree	38	77.6%
Master's Degree and above	11	22.4%
Total	49	100.0%
Years of experience of the respondent in the Construction Industry	Frequency	Percent
Less than 5 years	2	4.1%
5 -10 years	21	42.9%
10- 15 years	19	38.8%
Greater than 15 years	7	14.3%
Total	49	100.0%

Source: own survey, 2023

Most of the respondents were holders of BSc or BA degree. This out of the 49 respondents is 77.6% (38). The remaining 22.4% (11) are holders master's degree and above. As it is shown in Table 4.1, there is no respondent with diploma and below. This can indicate that the respondents are sufficient enough to provide relevant data for the study. Finally, greater than 965 of the respondents had a work experience higher than five years. This includes 21 (42.9%) between 5 and 10 years of experience, 19 (38.8%) between 10 and 15 years of experience, 7 (14.3%) greater than 15 years of experience. Similarly, only 2 (4.1%) out of the total 49 respondents had an experience of less than 5 years. From the work experience of the respondents, it can be said that the respondents were enough to answer the survey data relative to their work experience.

4.3. Current practice of Construction Equipment Management for AACRA

Current practice of construction equipment management for AACRA as shown in Table 4.2 was assessed. The SDA in the Table stands for strongly dis agree, DA stands for dis agree, N stands for neutral, A stands for agree and SA stands for strongly agree.

Regarding the presence of principles and guidelines of construction equipment management on the organization as shown in Table 4.2, 10.2% of the respondents strongly dis agree and 42.9% dis agree. 30.6% of the respondents neither agree nor dis agree. 16.3% of the respondents agree and no respondents strongly agree to the presence of principles and guidelines of their organization for equipment management. From this it can be understand that in the organization of the respondents there are not prepared and documented principles and guidelines for the management of construction equipment.

On the other hand, about the availability of equipment hiring and purchasing schedule in the organization, out of the total 49 respondents the 46.9% strongly dis agree, 18.4% dis agree. 20.4% of the respondents neither agree nor dis agree. 4.1% and 10.2% of the respondents. From the survey data it can be understand that the hiring and purchasing strategy of the organization is weak. The organization does not have fixed program to purchase construction equipment. On the other hand, regarding the organizational structure for the administration of construction equipment, 28.6% of the respondents strongly dis agree, 10.2% of the respondents dis agree, 24.5% of the respondents neither dis agree nor agree. While 24.5% of the respondents agree and 16.3% of the respondents strongly agree. Over all according to the respondents of the survey

data, AACRA has no well-structured structure for the administration of construction equipment in case of management and maintenance support.

Table 4.2 Current practices of management of construction equipment

Current practices		SDA-1	DA-2	N-3	A-4	SA-5	Total
The organization has construction equipment management principles and guidelines	Frequency	5	21	15	8	0	49
	Percent	10.2%	42.9%	30.6%	16.3%	0.0%	100.0%
The organization has Equipment hiring and purchasing schedule	Frequency	23	9	10	2	5	49
	Percent	46.9%	18.4%	20.4%	4.1%	10.2%	100.0%
The organization has structured construction equipment administration and maintenance support process	Frequency	14	5	10	12	8	49
	Percent	28.6%	10.2%	20.4%	24.5%	16.3%	100.0%
The organization has well staff capacity maintenance and their effectiveness on the construction equipment	Frequency	2	15	12	19	1	49
	Percent	4.1%	30.6%	24.5%	38.8%	2.0%	100.0%
The organization owns skilled equipment operator	Frequency	11	7	9	20	2	49
	Percent	22.4%	14.3%	18.4%	40.8%	4.1%	100.0%
The organization has capable drivers and operators	Frequency	7	2	21	19	0	49
	Percent	14.3%	4.1%	42.9%	38.8%	0.0%	100.0%
The organization has good equipment management practice	Frequency	29	13	4	2	1	49
	Percent	59.2%	26.5%	8.2%	4.1%	2.0%	100.0%
The organization has scheduled equipment upgrading and disposing system	Frequency	25	16	4	2	2	49
	Percent	51.0%	32.7%	8.2%	4.1%	4.1%	100.0%
The equipment allocation system of the organization is clear and scheduled	Frequency	19	16	9	2	3	49
	Percent	38.8%	32.7%	18.4%	4.1%	6.1%	100.0%
All the lots of the organization has their own garage office for simple maintenance of equipment’	Frequency	5	34	2	6	2	49
	Percent	10.2%	69.4%	4.1%	12.2%	4.1%	100.0%

Source: own survey, 2023

Capacity of staff on the maintenance of equipment is necessary for good management and work of an organization. According to the survey data, about the existing staff of maintenance effectiveness, 4.1% of the respondents strongly dis agree, 30.6% of the respondents dis agree, 24.5% of the respondents neither agree nor dis agree on the idea. 38.8% of the respondents agree and 2.0% of the respondents strongly agree. These states, some projects of the organization had efficient and effective capacity on construction equipment maintenance. While other has no effective maintenance staff.

The productivity of an equipment is dependent on its operator. As shown in Figure 4.2 22.4% of the respondents strongly dis agree and 14.3 % the respondents dis agree to the question 'the organization owns skilled equipment operator'. Out of the total respondents neither agree nor dis agree. According to the survey data there was no equipment maintenance and operation department on their site.

As stated in the Table 4.2 above, for the survey question 'the organization has capable drivers and operators' 14.3% of the respondents strongly dis agree and 4.1% of the respondent dis agree. This implies for the available equipment there are not capable enough operators and drivers. On the other side, 38.8% of the respondents agree with the idea. There was no respondent to strongly agree with the idea. This indicates in some sites for the available equipment there are capable drivers and operators. The availability of equipment and operators is not enough to good practice of equipment management. The management practice is very necessary. In response of the management practice of the survey data, 59.2% of the respondents strongly dis agree, 26.5% dis agree. On the other hand, only 4.1% and 2.0% agree and strongly agree with the idea respectively. From this it can be understand that the construction management practice of the company is very low. The remaining 8.2% of the respondents neither agree nor disagree with the idea.

For a sustainable management of construction equipment, an upgrading and disposing of old equipment is one section of the management class. The organizational practice according to the survey data is assessed. Accordingly, above half (51%) of the respondents strongly dis agree to the survey question 'The organization has scheduled equipment upgrading and disposing system'. 32.7% of the respondents also dis agree to the same question. This indicates that the organization neither upgrades and disposes old equipment. Even if their productivity is

decreased, hardly the construction equipment operates on the task of the organization. This leads to loss of productivity and delay of project. On the reverse, 8.25 of the respondents agree and dis agree with the idea. This shows in some sites there is a practice of upgrading and disposing of old equipment. But this system is not the practice of the organization in general. Assignment and allocation of construction equipment is very supportive issue on the management of construction equipment. Above 70% of the respondents strongly dis agree (38.8%) and dis agree (32.7%) on the survey question 'The equipment allocation system of the organization is clear and scheduled. This indicates the management practice of the organization regarding to equipment allocation and assignment is poor. While around 110% of the respondents agree (4.1%) and strongly agree (6.1%) on the same issue. The remaining 18.4% of the respondents prefer neutral (no comment) to neither agree no dis agree.

The last survey data on the current practice of the organization is 'all the lots of the organization has their own garage office for simple maintenance of equipment'. Here, around 80% of the respondents of the survey data strongly dis agree (10.2%) and dis agree (69.4%). This shows that most of the lots of the organization does not own their own garage. Maintenance of equipment for the lots is undertaking on the head office or nearest garage of the organization.

4.4. Factors that Affect Construction Equipment Management

In this section factors the factors that can affect management of construction equipment is analyzed according to the survey data collected from field survey.

Equipment policy related

Based on the survey data as shown in Figure 4.1 below, above 55% of the respondents strongly dis agree (22.4%) and dis agree (32.7%) on the survey question '**AACRA has written standards, guidelines and manuals procedures to manage construction equipment'**. This implies that the organization's management of construction equipment is weak. In reverse, 14.3% and 10.2% of the respondents agree and dis agree respectively to the same survey questionnaire. However, 20.4% of the respondents neither agree nor dis agree on the same idea. This shows that the neutral respondents do not want to give their comments regarding the presented question for the researcher.

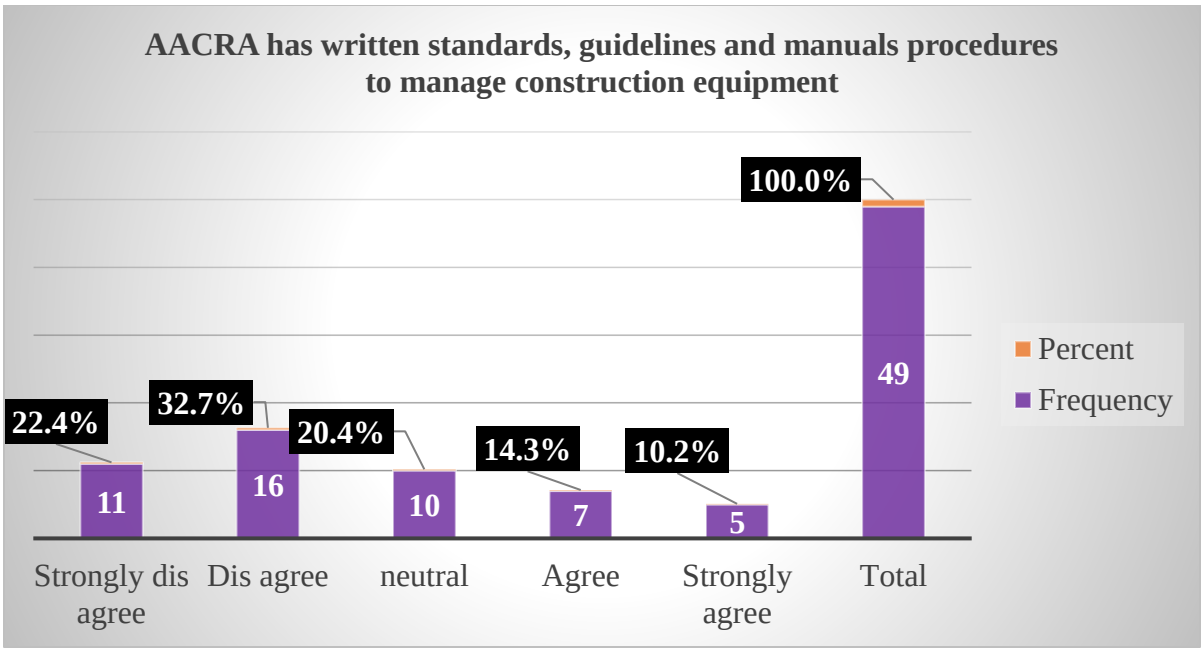

Figure 4.1 Written Standards, guidelines, manuals and procedures to manage construction equipment

Greater than 40% of the respondents strongly dis agree (4.1%) and dis agree (38.8%) regarding the clarity of manuals, standards, and procedures. According to the opinion of the respondents, the manuals, standards and procedures are not clear and easily understandable for the construction sites which they have. the opinion of the 26.5% of the respondents is neutral. This indicates that they cannot give a comment on the question because most of them already do not have manuals, standards and procedures for the effective management of construction equipment on their project (organization). As shown in the Figure 4.1 below again, out of the total survey data, the 22.4% respondent's opinion is agree and that of the 8.2% respondents is strongly agree. This indicates that the manuals, standards and procedures of some of the organizations that have manuals, standards and procedures are clear and easily understandable. However, most of the projects (lots) of the organization does not have manuals, standards and procedures.

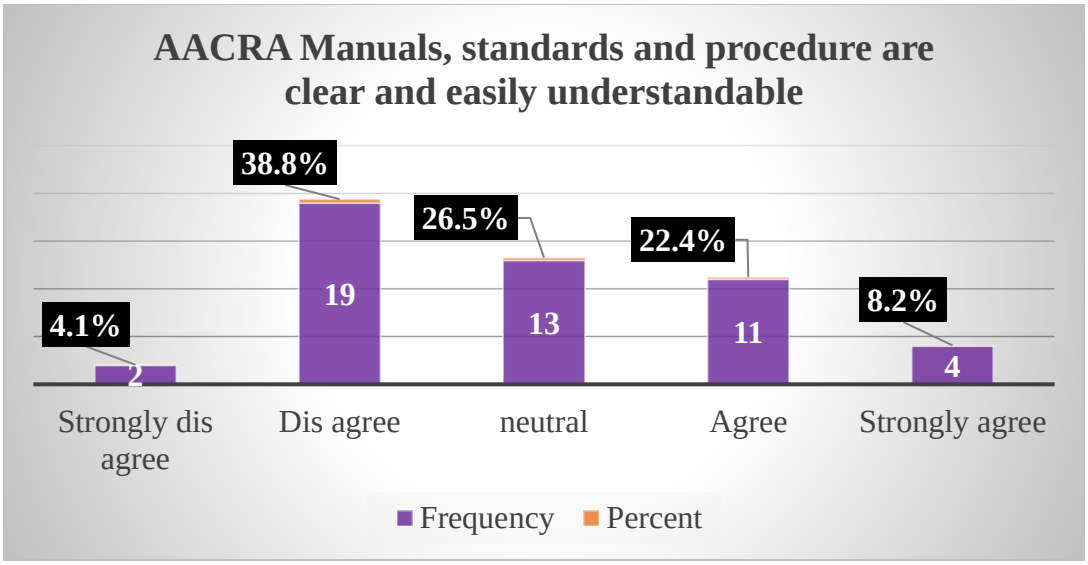

Figure 4.2 Clarity of manuals, standards and procedures

Equipment investment should be initiated from projects (sites) according to their requirements. If the proposal is persuasive the head office or respective body will approve. To assess the investment proposal, a survey was made and the result is shown in Figure 4.3 below.

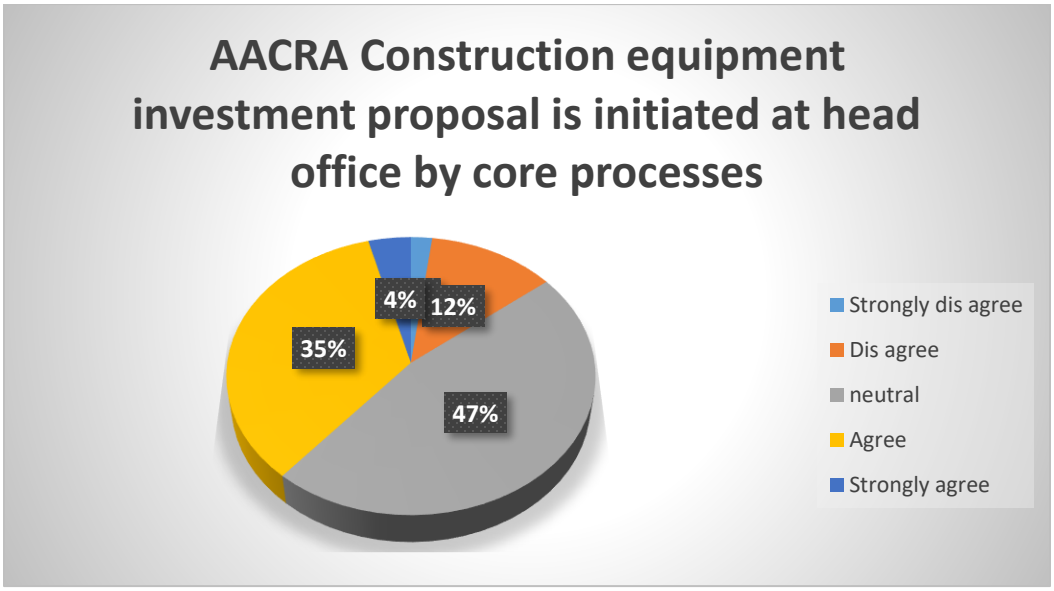

Figure 4.3 Initiation of proposal for the investment of equipment

According to the result of the survey, 35% of the respondents strongly agree and 4% of the respondents dis agree to the question or idea '**AACRA Construction equipment investment proposal is initiated at head office by core process'.** Only 2% of the respondents strongly diss

agree and 12% of the respondents dis agree. The remaining and the most percentage which is 47% out of the total respondent is neutral. The survey data shown in Figure 4.3 can dictate that, the initiation of investment proposal by head office is not acceptable by most of the projects.

Table 4.3 Equipment selection factor that affect management of construction equipment

Equipment selection related		SDA-1	DA-2	N-3	A-4	SA-5	**Total**
AACRA uses internally developed technical and financial criteria	Frequency	0	3	18	22	6	49
	Percent	0.0%	6.1%	36.7%	44.9%	12.2%	100.0%
AACRA uses standardization of construction equipment Least price criteria	Frequency	0	2	18	18	11	49
	Percent	0.0%	4.1%	36.7%	36.7%	22.4%	100.0%
AACRA uses Past experience and information from another user	Frequency	1	1	18	26	3	49
	Percent	2.0%	2.0%	36.7%	53.1%	6.1%	100.0%

Source: own survey. 2023

As stated in Table 4.3 above, above 50% of the respondents agree (44.9%) and strongly agree (12.2%) to the idea that 'AACRA uses internally developed technical and financial criteria'. Only 6.1% of the respondents dis agree to the same question. The remaining 36.7% of the respondent's choses neutral (neither agree nor dis agree). In sum, according to the survey data from respondents the technical and financial criteria of the organization is developed internally. In the same area, 36.7% of the respondents agree to the question 'AACRA uses standardization of construction equipment Least price criteria' and 22.4% of the respondents strongly agree to same question. Only 4.1% of the respondents dis agree to same survey question. The remaining 36.7% of the respondent's opinion is neutral. Within the same area, for selection of technical and financial criteria, based on the response of the respondents 53.1% of the respondents agree, 6.1% strongly agree, 36.7% of the respondents neutral, 2% of respondents strongly dis agree and equally 2% of respondents dis agree. From this in sum, rather than developing technical and financial criteria based on study and research, the organization uses past experiences.

As shown in Figure 4.4 below, survey data of integration of maintenance system of the organization was collected. Accordingly, 45% of the respondents strongly dis agree and 21% of the respondents dis agree. On the other hand, 14% of the respondents agree and only 4% of the

respondents strongly agree. The remaining 23% the respondents neither agree nor agree. In sum, the maintenance system of the organization has weak internal integration.

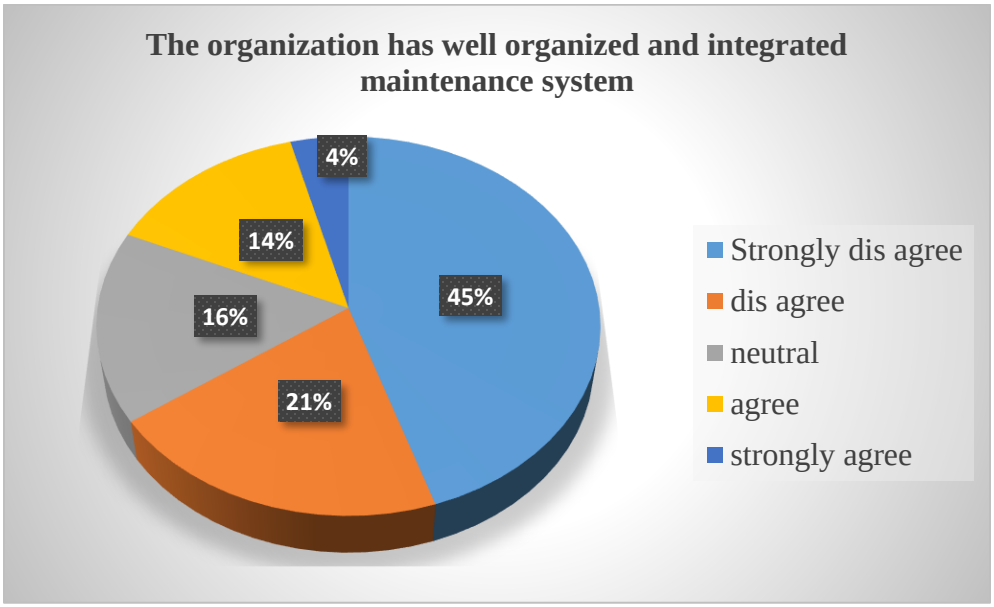

Figure 4.4 Integration of maintenance system

For the effective maintenance of construction equipment, clear and standard maintenance system of an organization is very important.

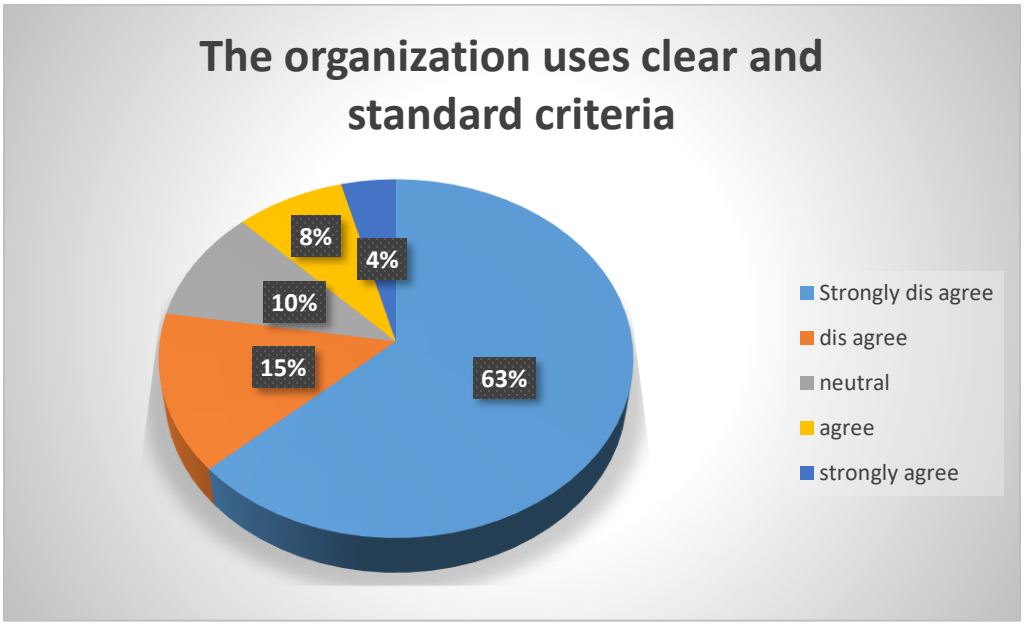

Figure 4.5 Standard and clear maintenance of the organization

To investigate the system of maintenance for the organization, a survey data was collected and presented in Table 4.5 below. Regarding on the data presented in Table 4.5, above half of the respondents strongly dis agree to the survey question '**The organization uses clear and standard criteria'** and 15% of the respondents dis agree. On the other hand, 8% of the respondents agree and 4% of the respondents strongly. The remaining 10% of the respondents neither agree nor dis agree.

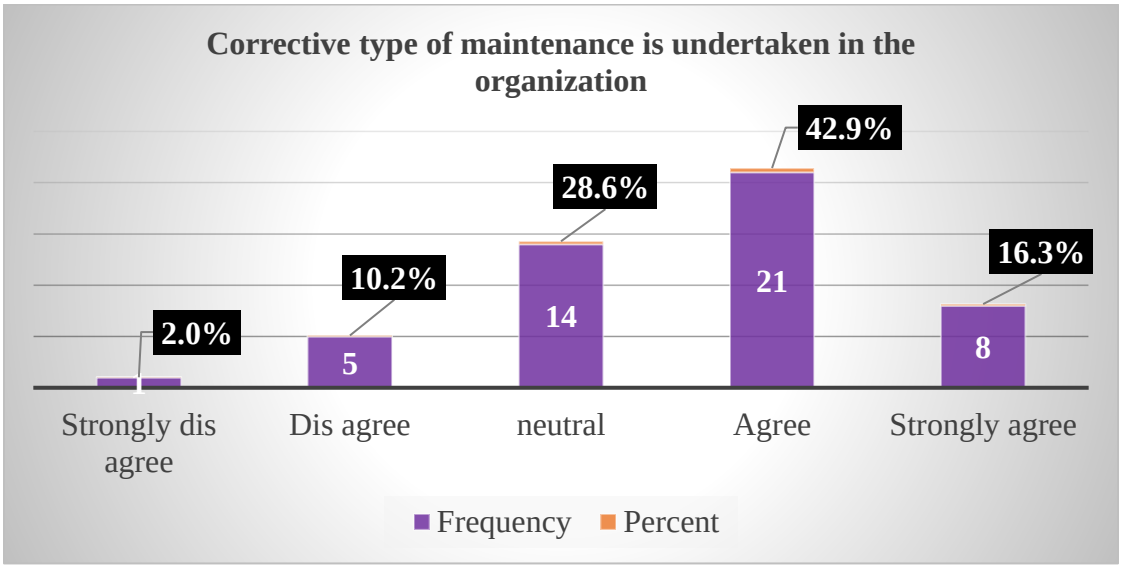

Figure 4.6 Corrective maintenance of the organization

There are two types of maintenance systems. Preventive maintenance and corrective maintenance. Preventive maintenance system is a system of maintaining and equipment in which before the equipment is failed, it is maintained and being serviced. On the other hand, corrective maintenance is a system of repairing an equipment after it is failed. To assess the mechanism of equipment maintenance a survey was collected on this area and presented in Figure 4.6 above. According to the survey data, 16.3% of the respondents strongly agree and 42.9% agree. On the other side, 2% of the respondents strongly dis agree, 10.2% of the respondents dis agree. The 28.6% of the respondents chose neutral. For best practice of an organization, preventive maintenance is preferable. However, as a result of the survey data indicated in Figure 4.6 the opinion of most of the respondents is that their organization uses corrective maintenance instead of preventive maintenance. This survey data is related to the idea that most of the projects of the organization has not their own garage as indicated in Table 4.2. This issue is related also to the

practice of the organization regarding clear and written manuals, standards and procedures how to maintain an equipment for minor damages prior to major damage.

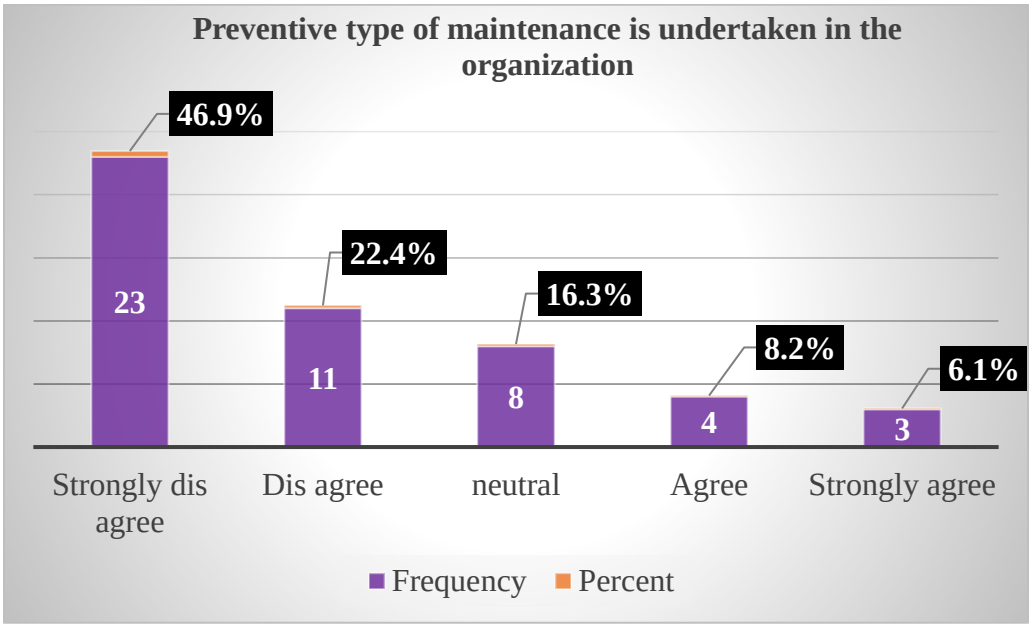

Figure 4.7 Preventive maintenance of the organization

Above 50% of the respondents strongly dis agree (46.9%), and 22.4% of the respondents dis agree to the survey question '**Preventive type of maintenance is undertaken in the organization**'. This indicates that the practice of preventive maintenance of an equipment on the organization is weak. This shows the equipment management system of the organization regarding preventive maintenance is poor. In line with the same survey question 16.3% of the respondents neither agree nor dis agree. This shows the organization (project) of the respondents either they do not use preventive maintenance or they do not have any knowhow or no comment regarding the preventive maintenance system of their organization. On the other hand, the answer of few respondents of the survey data confronts to the survey data of the most respondents. In this 8.2% of the respondents agree and 6.1% of the respondents strongly agree. this shows that some few projects of the organization use a preventive management system. This shows in sum the equipment management system of the organization regarding to preventive maintenance is weak.

'The organization makes economic analysis to replace equipment', 30.6% of the respondents strongly dis agree, 26.5% of the respondents dis agree and 16.3% of the respondents chose

neutral. Where, SDA stands for strongly dis agree, DA stands for dis agree, N stands for neutral, A stands for agree and SA stands for strongly agree in Table 4.4 below.

Table 4.4 Equipment replacement related factor that affect equipment management

Equipment replacement related		SDA-1	DA-2	N-3	A-4	SA-5	**Total**
The organization makes economic analysis to replace equipment	Frequency	15	13	8	10	3	49
	Percent	30.6%	26.5%	16.3%	20.4%	6.1%	100.0%
The organization replaces equipment when they are inefficient	Frequency	23	9	8	5	4	49
	Percent	46.9%	18.4%	16.3%	10.2%	8.2%	100.0%
The organization replaces old equipment before new project is hand over	Frequency	20	11	9	7	2	49
	Percent	40.8%	22.4%	18.4%	14.3%	4.1%	100.0%
The organization replaces equipment before major overhaul	Frequency	19	11	9	6	4	49
	Percent	38.8%	22.4%	18.4%	12.2%	8.2%	100.0%
The organization disposes construction equipment through third party	Frequency	21	6	14	5	3	49
	Percent	42.9%	12.2%	28.6%	10.2%	6.1%	100.0%

Source: own survey, 2023

On the other hand, 20.4% of the respondents agree and 6.15 of the respondents strongly agree. In the same area, for the replacement of inefficient equipment 46.9% of the respondents strongly dis agree, 18.4% dis agree, 16.3% neither agree nor dis agree. on the opposite side, 10.2% of the respondents agree, and 8.2% of the respondents strongly dis agree.

Based on the survey data shown on Table 4.4 above, 40.8% of the respondents strongly dis agree, 22.4% of the respondents dis agree. Neutrally 18.4% of the respondents neither agree nor dis agree. on the other hand, 14.3% of the respondents agree and 4.1% of the respondents strongly agree. In the same feeling, 38.8% of the respondents strongly dis agree, 22.4% of the respondents dis agree, and 18.4% of the respondents chose neutral. In negative sense to this,

12.2% of the respondents select agree and 8.2% of the respondents select strongly agree. The final survey data in this sub factor is disposal of construction equipment through third party. In this idea 42.9% of the respondents through strongly dis agree and 12.2% of the respondents through dis agree oppose the question to reverse. Because in the organization of the respondents, equipment is not being disposed during their salvage. in this idea 28.6% of the respondents prefers neutral to agree and dis agree. However, 10.2% of the respondents and 6.1% of the respondents through agree and strongly agree supports the survey question.

Table 4.5 Equipment benefit standardization related factor

Equipment benefit standardization related		SDA-1	DA-2	N-3	A-4	SA-5	**Total**
Standardizations can bring better performance of the organization	Frequency	2	3	9	16	19	49
	Percent	4.1%	6.1%	18.4%	32.7%	38.8%	100.0%
Standardizations can make ease for construction equipment management issues	Frequency	1	4	14	12	18	49
	Percent	2.0%	8.2%	28.6%	24.5%	36.7%	100.0%
Standardizations can lower maintenance costs	Frequency	2	5	11	14	17	49
	Percent	4.1%	10.2%	22.4%	28.6%	34.7%	100.0%

Source: own survey, 2023

Where, SDA stands for strongly dis agree, DA stands for dis agree, N stands for neutral, A stands for agree and SA stands for strongly agree in Table 4.5 above. Standardization of equipment for the effective utilization and management is very necessary. According to the survey data stated in Table 4.6 above, the respondents are very welcomed for the improved implementation of standards for a better management of construction equipment. For the survey question ‘Standardizations can bring better performance of the organization’ only 2% of the respondents does not accept through strongly dis agree and 8.2% through dis agree. The respondents without comment (neutral) are not few. This accounts for 18.4% out of the total

respondents. In line with the survey question, 32.7% and 38.8% of the respondents, match with through agree and strongly agree respectively. ‘Standardizations can make ease for construction equipment management issues’, in response to this survey question only 2% of the respondents and 8.2% of the respondents strongly dis agree and dis agree respectively. 28.6% of the respondents prefer neutral out of the other alternatives. While, 24.5% of the respondents and 36.7% of the respondents agree and strongly agree respectively out of the total respondents.

There are many alternatives to minimize maintenance costs. standardization is one of the mechanisms. as shown in Table 4.5 above, for the survey ‘Standardizations can lower maintenance costs’, 4.1% of the respondents strongly dis agree, 10.2% of the respondents dis agree, 22.4% of the respondents prefers neutral. On the other side, 28.6% of the respondents agree and 34.7% of the respondents strongly agree.

Another important issue on management of construction equipment is record keeping. Weaknesses and strengths happened, faults caused and other performances in the case of construction equipment should be recorded for future improvement. For the survey question ‘There is an appropriate method of data recording’, 51% of the respondents strongly dis agree and 26.5% dis agree. this shows that there is not appropriate record keeping in the projects of the organization. In line with this, 10.2% of the respondents select neutral. On the other hand, 8.2% of the respondents agree and 4.1% of the respondents strongly agree. The other next issue in the factor equipment record keeping is ‘Equipment utilization record is properly maintained both at head office and projects. In response to this, 53.1% of the respondents strongly dis agree, 24.5% of the respondents dis agree, and 12.2% of the respondents selects neutral. On the other hand, 2% of the respondents and 8.2% of the respondents agree and strongly agree to the same idea. from this it can be understand that the utilization of equipment is not utilized properly for future improvement and for the best next management of construction equipment. ‘Construction equipment costs are recorded properly’ is another survey question with the same area,65.3% of the respondents strongly dis agree, 14.3% of the respondents dis agree. On the other hand, 2% of the respondents agree and 12.2% of the respondents strongly agree. The remaining 6.1% of the respondents prefers neutral to neither agree nor dis agree. From this it can be understand that, the projects of the organization regarding the record keeping of equipment costa has a gap. Maintenance costs of the organization should be recorded also. In response to this 38.0% of the

respondents and 26.0% of the respondents strongly dis agree and dis agree to the survey question 'Maintenance data and costs are recorded properly'. On the other side, 8.0% and 6.0% of the respondents agree and strongly agree. The remaining 22.0% of the respondents neither agree nor dis agree.

Table 4.6 Equipment record keeping factor that affect equipment management

Equipment record keeping related		SDA-1	DA-2	N-3	A-4	SA-5	**Total**
There is an appropriate method of data recording	Frequency	25	13	5	4	2	49
	Percent	51.0%	26.5%	10.2%	8.2%	4.1%	100.0%
Equipment utilization record is properly maintained both at head office and projects	Frequency	26	12	6	1	4	49
	Percent	53.1%	24.5%	12.2%	2.0%	8.2%	100.0%
Construction equipment costs are recorded properly	Frequency	32	7	3	1	6	49
	Percent	65.3%	14.3%	6.1%	2.0%	12.2%	100.0%
Maintenance data and costs are recorded properly	Frequency	19	13	11	4	3	50
	Percent	38.0%	26.0%	22.0%	8.0%	6.0%	100.0%

Source: own survey, 2023

Availability of equipment and purchasing equipment by itself cannot improve management practice of an organization. Monitoring and controlling are necessary. In response to the monitoring and controlling of construction equipment, the opinion of the respondents is presented in Table 4.7 below. Accordingly, 36.7% of the respondents strongly dis agree, 24.55 of the respondents dis agree and 12.2% of the respondents prefers being neutral. On the other hand, 14.3% of the respondents and 12.2% of the respondents agree and strongly agree respectively for the same issue of the survey question. from this it can be understand that the inventory system of the projects of the organization is weak. With another question 'The organization equipment inventory system is effective and efficient' most of the respondents (46.9%) strongly dis agree and 12.2% of the respondents dis agree. The remaining 10.2% and 4.1% of the respondents agree and strongly agree while 26.5% of the respondents prefers neutral to neither agree nor dis agree. This indicates that the inventory system of the projects of the organization is not effective and efficient. Performance of an equipment is measured through controlling and monitoring. To achieve this an assessment was made on the projects of the organization 'The organization has

monitoring and controlling mechanism to evaluate performance of equipment' like this. In response of this question most of the respondents dis agree with the questionnaire. This dis agreement was through 40.8% with strongly dis agree and 14.3% with dis agree. This means the controlling and monitoring mechanism of the organization on the project of the respondents is weak and un applicable.

Table 4.7 Equipment monitoring and controlling factor that affect management of construction equipment

Equipment monitoring and controlling related		SDA-1	DA-2	N-3	A-4	SA-5	**Total**
The organization has construction equipment inventory system.	Frequency	18	12	6	7	6	49
	Percent	36.7%	24.5%	12.2%	14.3%	12.2%	100.0%
The organization equipment inventory system is effective and efficient	Frequency	23	6	13	5	2	49
	Percent	46.9%	12.2%	26.5%	10.2%	4.1%	100.0%
The organization has monitoring and controlling mechanism to evaluate performance of equipment.	Frequency	20	7	17	2	3	49
	Percent	40.8%	14.3%	34.7%	4.1%	6.1%	100.0%
The organization has effective and efficient monitoring and controlling mechanism to evaluate performance of equipment	Frequency	22	15	4	7	1	49
	Percent	44.9%	30.6%	8.2%	14.3%	2.0%	100.0%

Source: own survey, 2023

On the other hand, 4.1% of the respondents and 6.1% of the respondents agree and strongly agree with the idea respectively. This shows in some projects of the organization there is a monitoring and controlling of a construction equipment. The respondents with no comment or who chose neutral are not few. The are 34.7% from the total respondents.

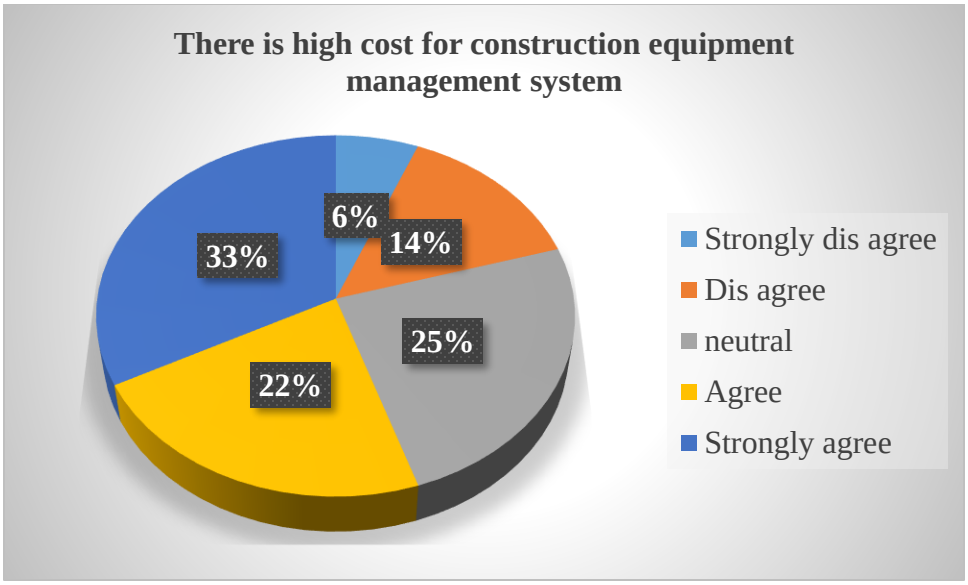

Figure 4.8 Cost for the management of construction equipment

As shown in Figure 4.8 above, 33% of the respondents strongly agree and 22% of the respondents agree. While only 6% of the respondents and 14% of the respondents strongly dis agree and dis agree. This indicates that, the management system of the organization for construction equipment exists but it is not working. It is only cost for the organization as compared with its work. On the other hand, 25% of the respondents neither agree nor dis agree. They prefer neutral to agree and dis agree. Therefore, it can be said that the revenue and cost of the management system in the projects of the organization does not balance. The cost is high according to the response of the respondents.

As shown in Figure, 31% of the respondents strongly dis agree, 26% dis agree, 27% of the respondents prefers neutral, 6% of the respondents agree and 10% of the respondents strongly agree. Most of the respondents strongly dis agree and dis agree with the survey question '**Non-Availability of skilled manpower in the construction equipment management system'**. Few numbers of respondents only agree with the same idea. From this it can be understand that there is availability of skilled man power in the area of equipment management. However, due to the poor internal management system of the construction equipment department area, the sense looks as there is poor availability of skilled man power in the area of construction management system in the projects of the organization.

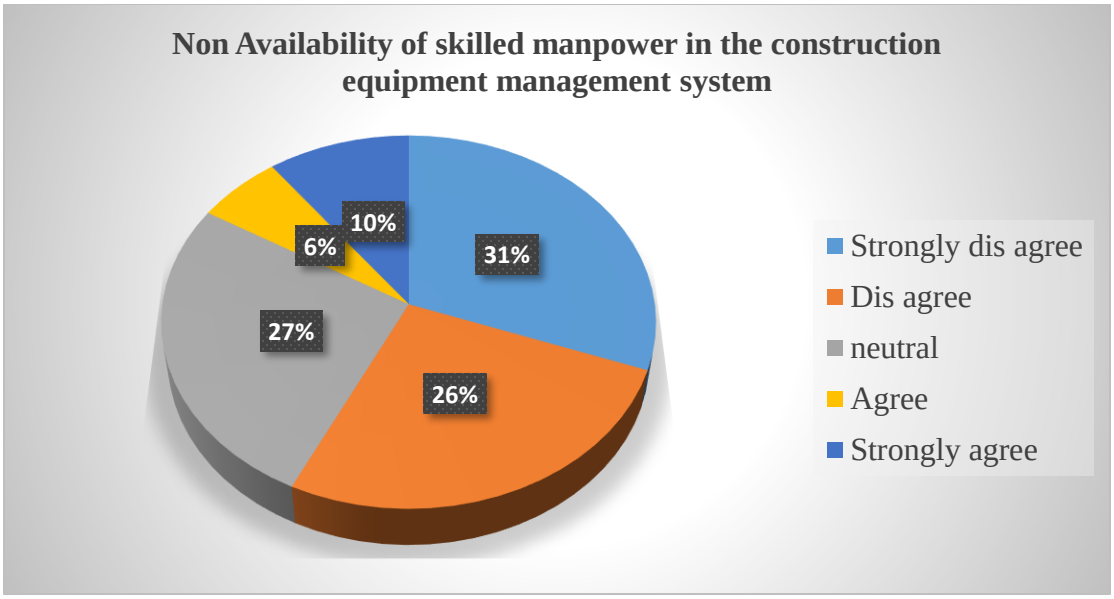

Figure 4.9 Availability of skilled man power in construction industry

4.5. Suggestions of best practice of construction equipment management

Interviews and observations were made in the study area to investigate best practice of construction equipment. Accordingly, the results of the interview and observation are presented in the Tables and Figures below.

Table 4.8 Maintenance of construction equipment on site

Do you think that on-site equipment maintenance can improve construction equipment management?	Frequency	Percent
Yes	49	100%
No	0	0%

Source: own survey, 2023

As shown in Table 4.8 above, availability of maintenance of construction equipment in site for the improvement of management of construction equipment is the opinion of all the respondents. According to the observation of the researcher, the availability of site maintenance is very important and can improve management of construction equipment. This is due to many reasons. one is if in case an equipment damaged in work, for maintenance the equipment stays long time until the equipment is maintained from head office. The second reason is that the manager of the

equipment cannot operate with the damaged equipment and therefore difficult. Third reason is that productivity of the site at all halts due to the absence of site maintenance. However, if there is a site maintenance the equipment manager can handle easily the equipment under his control.

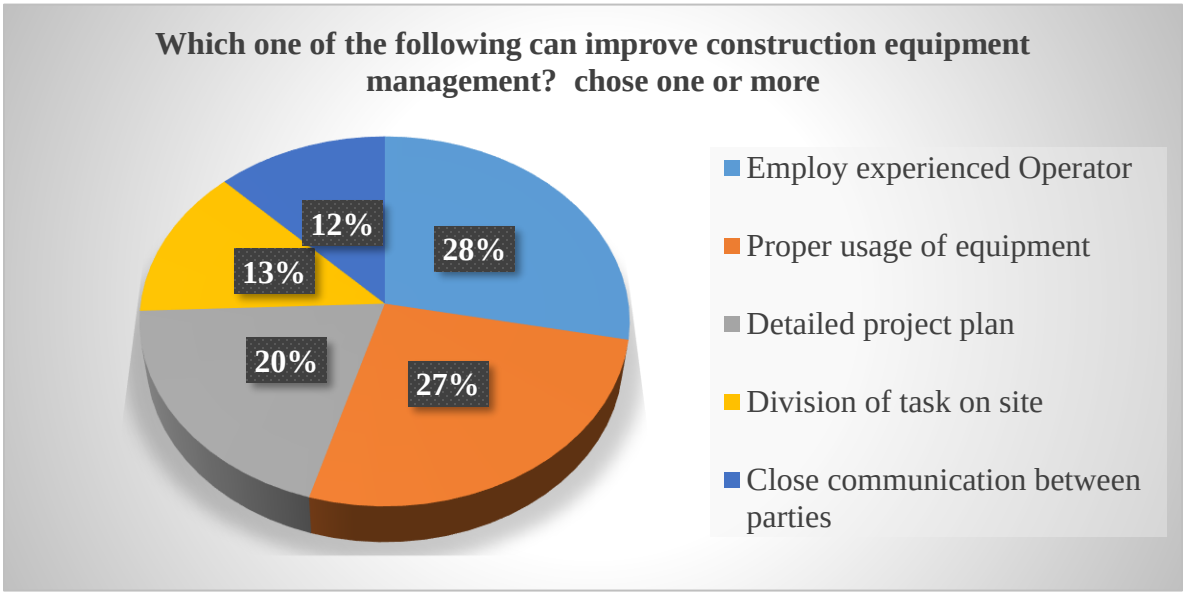

Figure 4.10 Items of ideas that can improve construction equipment management

According to the survey data gather as indicated in Figure 4.10 above, there are many alternatives of ideas to improve construction equipment management. The first idea is Employment of well experienced equipment operator. This can improve at least that the equipment can work without damage for a long time. However, if the equipment is operated with unskilled operator, it may be damaged in in a short period of time and leads to additional costs. The other important idea for the improvement of construction equipment as stated in Figure 4.10 is proper usage of an equipment. This mostly applicable for rental equipment. The operator and the management of the organization must operate the equipment with the sense of belongingness. Division of task on site regarding to construction equipment is another issue that can improve management of construction equipment. Manager should not try to maintain damaged equipment. Equipment operator could not try to manage all equipment in the organization. Individuals should fulfill only their own task. The final important point for an improvement of equipment management based on the respondent is close communication with in the organization. Equipment operator should closely communicate with his manager or team leader

regarding the equipment he/she is operating. This applies for all the personnel working on the organization.

Table 4.9 Controlling contractor for improved equipment management

Do you think that close control of contractor on site improve management of construction equipment?	Frequency	Percent
Yes	43	88%
No	6	12%
Total	49	100%

Source: own survey, 2023

The interview question result presented in Table 4.9 above is for external contractors (rental equipment) operating in the organization. Accordingly, 88% of the respondents suggests controlling close control of rental equipment can improve management of construction equipment. only 6 respondents (12%) does not recommend this idea. In sum, according to the response of the survey respondents' close control of rental equipment can improve equipment management.

Another important point in this area according to the survey data is structural organization of equipment management system. This structure helps everyone in the structure to accomplish his own task. In addition to this rental assignment of equipment can help and solve the shortage of equipment in the organization. According to survey the survey data, there are no enough equipment in the sites of the organization, garage in site is not available in most construction projects of the organization, old equipment are being used in the sites, there is not enough assignments of equipment in the sites, maintenances of equipment is in head office and in some sites that have garage, damaged rental equipment is maintained with the cost of sub-contractors, there is no clear reporting system regarding maintenance report of equipment in the organization, allocation and assignments of equipment is not based on plan. In general, the management of construction equipment in the organization is poor according to the opinion of the respondents.

4.6. Descriptive analysis of data using SPSS

4.6.1. Descriptive analysis of data using SPSS

For simplicity of analysis using SPSS software, shorthand of string was used. Based on this, CP1=The organization has construction equipment management principles and guidelines, CP2=The organization has Equipment hiring and purchasing schedule, CP3=The organization has structured construction equipment administration and maintenance support process, CP4=The organization has well staff capacity maintenance and their effectiveness on the construction equipment, CP5=The organization owns skilled equipment operator, CP6=The organization has capable drivers and operators, CP7=The organization has good equipment management practice, CP8=The organization has scheduled equipment upgrading and disposing system, CP9=The equipment allocation system of the organization is clear and scheduled, CP10=All the lots of the organization has their own garage office for simple maintenance of equipment.

Table 4.10 Descriptive analysis using SPSS software

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
CP1	49	1.00	4.00	2.5306	.89214
CP2	49	1.00	5.00	3.4082	1.03920
CP3	49	2.00	5.00	3.7551	.85466
CP4	49	1.00	5.00	3.0408	.97808
CP5	49	2.00	5.00	3.5714	.79057
CP6	49	2.00	4.00	3.4898	.58175
CP7	49	1.00	4.00	2.7959	1.02020
CP8	49	1.00	5.00	3.0612	1.02892
CP9	49	1.00	5.00	3.0408	1.04002
CP10	49	1.00	5.00	2.3061	.96186
Valid N (listwise)	49				

Source: analysis work through SPSS (2023)

As shown in Table 4.10 above, the standard deviation of the current practices is close to one (1). This implies that the survey data used for the investigation of current practice equipment management in the organization are price to each other.

4.6.2. Correlation of variables used for data survey using SPSS

As shown in Table 4.11 below, the significance of the variables is in 0.000level. which is significant.

Table 4.11 Correlation of variables used for current practice

Correlations											
		CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP9	CP10
CP1	Pearson Correlation	1	.840**	.884**	.858**	.743**	.813**	.877**	.872**	.874**	.851**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
CP2	Pearson Correlation	.840**	1	.889**	.885**	.877**	.869**	.886**	.892**	.871**	.685**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
CP3	Pearson Correlation	.884**	.889**	1	.835**	.890**	.749**	.873**	.823**	.832**	.803**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
CP4	Pearson Correlation	.858**	.885**	.835**	1	.831**	.879**	.906**	.970**	.899**	.651**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
CP5	Pearson Correlation	.743**	.877**	.890**	.831**	1	.738**	.845**	.827**	.757**	.614**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
CP6	Pearson Correlation	.813**	.869**	.749**	.879**	.738**	1	.839**	.889**	.793**	.546**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000	.000

	N	49	49	49	49	49	49	49	49	49	49
CP7	Pearson Correlation	.877**	.886**	.873**	.906**	.845**	.839**	1	.905**	.911**	.702**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
CP8	Pearson Correlation	.872**	.892**	.823**	.970**	.827**	.889**	.905**	1	.913**	.675**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.000	.000
	N	49	49	49	49	49	49	49	49	49	49
CP9	Pearson Correlation	.874**	.871**	.832**	.899**	.757**	.793**	.911**	.913**	1	.779**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000		.000
	N	49	49	49	49	49	49	49	49	49	49
CP10	Pearson Correlation	.851**	.685**	.803**	.651**	.614**	.546**	.702**	.675**	.779**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	
	N	49	49	49	49	49	49	49	49	49	49
**. Correlation is significant at the 0.01 level (2-tailed).											

Table 4.12 Regression model and Autocorrelation test

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.930[a]	.864	.855	.33982
a. Predictors: (Constant), EI2, EP2, EI1				

According to table 4.12, the correlation between the independent and dependent variables is R (.930). According to the model explanation above, R Square is 0.864 and R Square with adjustments is 0.855. This reveals the percentage of variance in the dependent variable (Equipment management) that can be accounted for by the independent variables Equipment policy, Equipment investment, Equipment selection, Equipment maintenance, Equipment replacement, Equipment benefit standardization, Equipment record keeping, Equipment monitoring and controlling and Equipment management challenges). Since this regression also

uses many independent variables, the adjusted R square is considered. This suggests that the dependent variable was 86.4% explained by the model (independent variable).

Table 4.13 ANOVA result

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	33.008	3	11.003	95.280	.000[b]
	Residual	5.196	45	.115		
	Total	38.204	48			
a. Dependent Variable: CP1						
b. Predictors: (Constant), EI2, EP2, EI1						

The above Table 4.13 shows that statistically there is significant contribution, as indicated by the Sig. value equal to 0.000. Therefore, the ANOVA table indicates that the model as a whole is significant at p<=0.05. The F-ratio in the ANOVA table tests whether the overall regression model is a good fit for the data. The F value shows 95.28 which is greater than the F critical=1.922 it shows the model is significant which implies the coefficients included in the model improved the model fit.

Table 4.14 ANOVA result

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	37.926	27	1.405	106.264	.000[b]
	Residual	.278	21	.013		
	Total	38.204	48			
a. Dependent Variable: CP1						
b. Predictors: (Constant), EMC2, EM2, ES1, ES3, EB2, EM1, EM4, ES2, EC4, ER5, EK2, EC2, ER1, EP2, EB3, EMC1, EK1, ER4, EI1, EK3, EM3, ER3, EK4, EC3, EC1, ER2, EB1						

4.7. Case study

Background of the projects of the case study:

To support the questioner and interview with practical site observation case study is employed. Through this, the extent of management of construction equipment is examined with in the selected projects for the case study. Data was collected thoroughly from the projects in order to support the study. Excavator, Loader and Backhoe were the targets of the case study.

The purchasing department of the company purchases machines based on the departments assessment of equipment requirement in the organization. The company allocates the purchased and leased machines to all the lots depending up on the amount of equipment on hand. As discussed in chapter three of this paper, lot-2 has 9 projects. according to the case study made on this lot, there are only 3 excavators, 3 loaders and 2 backhoe. Even for the available machineries, maintenance and repairing is based on the schedule of the maintenance office not based on the requirement of the project and the equipment service needed. Machineries disposal is after many repairmen's made and when the machine stops movement. This is for both rental and own equipment. From the case study the following are the findings:

- Equipment proposal and purchase is from head office. This does not include the capacity and requirement of the projects of the lot.
- Equipment allocation is even. This means the assignment does not include the scope of the project and equipment requirement of the project.
- There is no respective body and respective department to study the productivity of equipment.
- During equipment damage, nothing cannot be done on site. Because there is no garaged in the projects of the lot. The site engineer or the project manager will inform to head office. After a long process maintenance group will be assigned from head office.
- Equipment disposal takes very long time. Equipment to be disposed, it should be completely damaged and stop moving.

Therefore, the survey data collected from the case study is consistent with the questionnaire and interview data.

4.8. Summary of Findings

- ✓ The background information of the respondents shows most of the survey respondents were site engineer and office engineer (59.2%). The remaining 24.5% and 16.3% of the respondents were team leaders and managers respectively. All the respondents (100%) were educated enough. This shows the respondents had a BSc/BA degree and above. 42.9% of the respondents had an experience of 5 to 10 years and 38.8% of the respondents had 10 to 15 years of experience. The remaining 14.3% and 4.1% of the respondents had an experience of greater than 15 years and below 5 years respectively.
- ✓ In the organization there are no principles and guidelines for managing construction equipment. This is the opinion of greater than 52% of the respondents. There is no proper schedule for hiring and purchasing construction equipment. Opinion of more than 65% of the respondents is improper hiring and purchasing of equipment. Regarding the organizational structure of equipment management, above 40% of the respondents believes in their organization as there is no proper structured organization of equipment management. The organization has enough and capable staff for equipment maintenance (based on the opinion of more than 40% of the respondents) but the distribution of the maintenance department and personnel is not organized and structured well. The organizations practice regarding equipment upgrading, equipment disposal, equipment allocation (assignment) in summary is considered as poor (depending on the opinion of more than 70% of the respondents).
- ✓ In sum, it is concluded that the organization has not clear procedures, manuals, and standards (based on the opinion of more than 40% of the respondents). Construction investment proposals of the organization are developed at head office. This causes poor construction equipment management in projects (according to about 38% of the survey data). Qualitative and quantitative evaluation is monopolized in head office only. Technical and financial criteria are not developed internally. For maintenance of equipment, the organization had not clear and standard criteria, poor and not integrated internal organization (about 65% of the respondents' idea). Corrective type of maintenance (60% of the respondents' opinion) is used instead of preventive maintenance system (70% of survey data). Replacement is not based on economic analysis.

Replacement of equipment is not based on schedule; it is random (the idea above 55% of the survey data). Equipment is not disposed in the organization purposely, if it sounds it works even with too low productivity (the opinion of more than 40% of survey data). Based on the analysis standardization brings better performance, can make easy management of construction equipment, can lower maintenance costs (this is the opinion of more than 52% of the respondents). Equipment performance, equipment utilization, equipment cost for operation and maintenance, in the organization are not recoded properly in the organization (above 70% of the survey data). Equipment inventory in the organization is poor (60% of respondents' opinion), evaluation and controlling of performance of equipment in AACRA is not preforming good. For managing construction equipment, high cost of management is spending, while the responsible bodies are not performing their duties.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis made in this paper the following conclusions and recommendations are drawn.

5.1. Conclusions

From the study, the following conclusions were drawn

- ✓ From the current practice of the organization, no principles and guidelines for managing construction equipment. There is no proper schedule for hiring and purchasing construction equipment. In the organization, there is no structured and organized administration for the maintenance of construction equipment. The organization has enough and capable staff for equipment maintenance but the distribution of the maintenance department and personnel is not organized and structured well. In some sites there is strong maintenance office while in other sites (projects) there is no maintenance. Available equipment is not thoroughly operated with skilled equipment operator and drivers. The organizations practice regarding equipment upgrading, equipment disposal, equipment allocation (assignment) in general was considered as poor. Because, old equipment is still in use at site without upgrading, equipment allocation is random rather than based on study and requirement.
- ✓ Equipment related factor: it is concluded that the organization has not clear procedures, manuals, and standards. Regarding to investment, construction investment proposals of the organization are developed at head office. This causes poor construction equipment management in projects. Regarding the qualitative and quantitative evaluation, the evaluation is monopolized in head office only. For the selection of equipment for construction projects, technical and financial criteria are not developed internally. In purchasing equipment, least price is selected. Equipment for assignments is based on past experience rather than based on study and analysis. For maintenance of equipment, the organization had not clear and standard criteria, poor and not integrated internal organization. Corrective type of maintenance is used instead of preventive maintenance system. Old equipment should be replaced based on analysis. However, in the

organization equipment is not replacing based on analysis and on time. Replacement is not based on economic analysis. Replacement of equipment is not based on schedule, it is random. Some times when new projects hand over, sometimes old equipment is used in new project also. Old equipment is not disposed in the organization purposely, if it sounds it works even with too low productivity. Based on the analysis it is concluded that standardization brings better performance in the organization. This also can make easy management of construction equipment, can lower maintenance costs. Equipment performance, equipment utilization, equipment cost for operation and maintenance, in the organization are not recoded properly in the organization. Overall, record keeping of equipment in the organization is too poor in the organization. Equipment inventory in the organization is poor, evaluation and controlling of performance of equipment in AACRA is not preforming good. From this it is concluded that, equipment controlling and monitoring in the organization is not organized and integrated well. For managing construction equipment, high cost of management is spending, while the responsible bodies are not performing their duties. From the analysis it is concluded that skilled equipment managers are available. However, their management system in construction equipment is responsibility less.

- ✓ From the interviews collected from respondents in general, in AACRA equipment management system from hiring to disposal is poor. Hiring and purchasing of equipment is not based on internal requirement and not based on economic analysis. Old (traditional) management system is used in the organization. There are enough equipment operators in the organization. However, the management of construction equipment is very poor. The operators and garage experts cannot without ordering from the management. In sum, for maintaining damaged equipment there is long bureaucracy. This affects the quality and functionality of management of construction equipment. For the improvement of management of construction equipment, well organized structural organization of equipment, scheduled equipment management, transferring of authority for responsible body, proper site supervision, detailed equipment work plan, close communication of equipment operating and managing parties are the recommended better that can improve construction equipment management practices.

5.2. Recommendations

Based on the practices of the study area as a result of the analysis and conclusions drawn above, recommendations are drawn below for the study are and for future study.

5.2.1. Recommendations from the study

Management of construction equipment is investigated in Addis Ababa City Road Authority 9AACRA). Accordingly, the following recommendations have been forwarded for the study organization in order to have better management of construction equipment:

- ✓ AACRA should have well-developed manuals, principles and standards for the effective management of construction equipment that incorporates how to hire, purchase, assign, upgrade, maintain and dispose construction equipment.
- ✓ AACRA should have well developed organizational structure of construction equipment and responsibility of personnel to manage the equipment from hiring a new equipment to disposing an old equipment.
- ✓ Hiring and purchasing of equipment should be based on investigation in each projects of the organization. This helps to purchase critical construction equipment at the right time for the right purpose.
- ✓ The organization should employ very skilled and experienced personnel for operating, maintaining, upgrading and managing construction equipment
- ✓ At least simple garages should be available on construction projects of the organization for sustainable construction progress. This helps the organization to simply control and manage construction equipment. Simple damages will not wait for maintenance from head office.
- ✓ It is advised the organization to develop technologically advanced inventory system. This enables the organization to control its inventory system through system. In this inventory system it is also advised to have online registration for assignment of equipment, equipment damage and other necessary requirements to decrease the long bureaucracy of the organization and to improve the construction equipment management system.

5.2.2. Recommendations for Future study

- ✓ Investigation of equipment inventory in Addis Ababa City Road Authority to maximize equipment management system.
- ✓ comparative study of equipment management system in local and foreign contractors for enhanced construction equipment management system

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APPENDIX

Appendix A: Questionnaire

Survey Questionnaire

Dear Sir,

The researcher is conducting this study for the purpose of the partial fulfillment of the requirement for the MSc degree in "Construction Technology and Management" with a research title of " **ASSESSMENT ON CONSTRUCTION EQUIPMENT MANAGEMENT PRACTICE IN ROAD CONSTRUCTION PROJECTS: CASE STUDY ON ADDIS ABABA CITY ROAD AUTHORITY**". The objective of the study is to evaluate the current practice of equipment management, to identify factors affecting equipment management, and to suggest best practice of equipment management Addis Ababa City Road Authority. The questionnaire is for the purpose of academic research in which the confidentiality of all respondents shall be respected.

Thank you!

Michael Mulugeta (0920060730)

Instructions

The questionnaire will have three parts

Part one will be discussing on the respondent general information and overall project information which the respondent is working on.

Part One: General Information:

Please add (√) in the box below which is appropriate: for you:

1. **Gender**

☐ Male

☐ Female

2. **Your organization**:
   - ☐ Client and Internal contractor
   - ☐ External Contractor (sub-contractor)
   - ☐ Consultants

3. **Job Position**

☐ Middle manager (Project Team Leader, Project Site Supervisor, Office/Contract Engineer)

☐ Top manager (Project Manager Position, Design team leader, Resident Engineer, Owner)

☐ Project manager

Other, please specify_____

4. **Educational background:**

☐ ≤ Diploma

☐ BSc/BA degree

☐ Master's Degree and above

5. **Years of experience of the respondent in the Construction Industry**

☐ Less than 5 years

☐ 5 -10 years

☐ 10- 15 years

☐ Greater than 15 years

Part Two:

2.1. Assessment of current practice of management of construction equipment

Please, put a tick mark (√) on the appropriate column according to their degree of rank on your organization. Rank of your response on each question by analyzing their significant influence on your project: For level of influence use levels; 1=strongly dis agree, 2=dis agree, 3=neutral, 4= agree, and 5=strongly agree

	Current practices	1	2	3	4	5
1	Contractor has construction equipment management principles and guidelines					
2	The organization has Equipment hiring and purchasing schedule					
3	The organization has structured construction equipment administration and maintenance support process					
4	The contractor has well staff capacity maintenance and their effectiveness on the construction equipment					

5	The organization owns skilled equipment operator					
6	The organization has capable drivers and operators					
7	The contractor has good equipment management practice					
8	The contractor has scheduled equipment upgrading and disposing system					
9	The equipment allocation system of the contractor is clear and scheduled					
10	All the lots of the organization has their own garage office for simple maintenance pf equipment'					

2.2. Factors that affect equipment management practice

Please, put a tick mark (√) on the appropriate column according to their degree of rank on your organization. Rank of your response on each question by analyzing their significant influence on your project: For level of influence use levels; 1=strongly dis agree, 2=dis agree, 3=neutral, 4= agree, and 5=strongly agree

Factors affecting management of equipment management		1	2	3		
1	AACRA has written standards, guidelines and manuals procedures to manage construction equipment					
2	AACRA Manuals, standards and procedure are clear and easily understandable					
3	AACRA Construction equipment investment proposal is initiated at head office by core processes					
4	AACRA uses internally developed technical and financial criteria					
5	AACRA uses standardization of construction equipment Least price criteria					
6	AACRA uses Past experience and information from another user					
7	The Contractor has well organized and integrated maintenance system					
8	The Contractor uses clear and standard criteria					

9	The Contractor has well organized and integrated maintenance system					
10	Corrective type of maintenance is undertaken in the Contractor					
11	Preventive type of maintenance is undertaken in the Contractor					
12	The Contractor makes economic analysis to replace equipment					
13	The Contractor replaces equipment when they are inefficient					
14	The Contractor replaces old equipment before new project is hand over					
15	The Contractor replaces equipment before major overhaul					
16	The Contractor disposes construction through third party					
17	Standardizations can bring better performance of the Contractor					
18	There is an appropriate method of data recording					
19	Equipment utilization record is properly maintained both at head office and projects					
20	Construction equipment costs are recorded properly					
21	Maintenance data and costs are recorded properly					
22	The Contractor has construction equipment inventory system.					
23	The Contractor equipment inventory system is effective and efficient					
24	The Contractor has monitoring and controlling mechanism to evaluate performance of equipment.					
25	The Contractor has effective and efficient monitoring and controlling mechanism to evaluate performance of equipment.					
26	The high cost of construction equipment management system					
27	Availability of skilled manpower in the construction equipment management system					

Part three: Interview questions

A. For internal contractor (Client)

1. Do you have a garage on your site?

☐ Yes

☐ No

2. Do you have enough equipment on your site to execute your project work?

☐ Yes

☐ No

3. Are you satisfied with the equipment management system in your site?

☐ Yes

☐ No

4. If your answer in number 3 above is "No", please specify your reason.

_____

_____

_____

5. Do you use salvage (old) equipment in your project execution?

☐ Yes

☐ No

6. Do you think that the assignment of equipment for your project is enough for your work?

☐ Yes

☐ No

7. Where do you get a maintenance for simple equipment damage?

☐ On site

☐ On head office

B. For external contractors (Sub-contractors)

8. Do you have a maintenance on the project you are working on?

☐ Yes

☐ No

9. Any equipment damage of the sub-contractor is maintained with the cost of the sub-contractor.

☐ Yes

☐ No

10. Does your project reports for equipment maintenance every year to AACRA main maintenance office?

☐ Yes

☐ No

11. If your answer in number 10 above is “Yes”, when do you report to the main office?

☐ Monthly

☐ Quarterly

☐ Yearly

If other, please specify, _____

12. Equipment allocation is based on the yearly plan of the AACRA

☐ Yes

☐ No

C. For best practice of construction equipment management

13. Do you think that on-site equipment maintenance can improve construction equipment management?

☐ Yes

☐ No

If other, please specify: _____.

14. Which one of the following can improve construction equipment management? Please choose one or more of the following if you agree.

☐ Employ experienced Operator

☐ Proper usage of equipment

☐ Division of task on site

☐ Detailed project plan

☐ Close communication between parties

Please, specify if other_____

15. Do you think that close control of contractor on site improve management of construction equipment?

☐ Yes

☐ No

If other, please other: _____.

16. Do you think that equipment structural management system can improve management of construction equipment?

☐ Yes

☐ No

If other, please other: _____.

17. Do you agree that rental assignment of equipment will improve management of construction equipment?

☐ Yes

☐ No

If other, please other: _____.

Appendix B: Secondary Data

No.	Lot-1	ርዝመት በሜትር	የመንገዱ ስፋት	Type of work	Lot
1	አፍሪካ ህንፃ-ጀሞ መስታዎት ፋብሪካ			Road Maintenace	1
2	ቂርቆስ ማርገጃ-ቡልጋሪያ	1500	20	Road Maintenace	1
3	ሰሚት የጋራ መኖሪያ (40/60)	900	12	Road Maintenace	1
4	ቀራንዮ ድልድይ	1		Bridge Maintenance	1
5	ቤላ መንገድ - ፈረንሣይ ፓርክ - ፈረንሣይ አቦ ቤተክርስቲያን	1200	15	Road Maintenace	2
6	ቀጨኔ ቁስቁም አስፋልት መንገድ	2000	16.5	Road Maintenace	2
7	የኢትዬጵያ ብሮድካስት ኮርፖሬሽን	1957.49	5 & 2	Road Maintenace	2
8	ድል በር-ፍተሻ ኬላ መንገድ	1000		Road Maintenace	2
9	ማዘር ትሬዛ	1		Bridge Maintenance	2
10	በላይ ዘለቀ /አጣሪ ድልድይ	1		Bridge Maintenance	2
11	አፍንፏ በር ድጋፍ ግንብ	200		Support wall work	2
12	መገናኛ -ቀበና- ኬንያ ኤምባሲ-አንቆርጫ (A1 & A2 roads)	7500	12	Road Maintenace	3
13	መገናኛ -ቀበና- ኬንያ ኤምባሲ-አንቆርጫ (B roads)	7770.843	6.7	Road Maintenace	3
14	አራራት ኮተቤ ኮሌጅ	2840	30	Road Maintenace	3
15	ኮተቤ አማኑኤል - ኮተቤ ሩት መንገድ አስፋልት መንገድ	1500	25	Road Maintenace	3
16	አአከመባ አዲሱ ጋራዥ መንገድ ፕሮጀክት	1200	8	Road Maintenace	4
17	ናሰዉ ሪል ስቴት አርሴማ ቀለበት መንገድ	1280	30	Road Maintenace	4
18	ቃሊቲ ቶታል ኢቃቂ ድልድይ ቱሉ ዲምቱ አደባባይ መንገድ	5660	25	Road Maintenace	4
19	ፋፋ ምግብ ፋብሪካ- ዳማ ሆቴል -ብሄረ ፅጌ-ደብረዘይት መንገድ	600		Road Maintenace	4
20	ገላን ኮንዶሚኒየም-ሰላም ህንፃ	400		Road Maintenace	4

Appendix C: Analysis Data

Gender		Frequency	Percent
Male		35	71.4%
Female		14	28.6%
Total		49	100.0%
Your organization		Frequency	Percent
Client (Owner)		39	79.6%
External Contractor (Rental)		10	20.4%
Other, please specify		0	0.0%
Total		49	100.0%
Job Position		Frequency	Percent
Manager		8	16.3%
Team Leader		12	24.5%
site Engineer or Office Engineer		29	59.2%
Total		49	100.0%
Educational background		Frequency	Percent
≤ Diploma		0	0.0%
BSc/BA degree		38	77.6%
Master's Degree and above		11	22.4%
Total		49	100.0%
Years of experience of the respondent in the Construction Industry		Frequency	Percent
Less than 5 years		2	4.1%
5 -10 years		21	42.9%
10- 15 years		19	38.8%
Greater than 15 years		7	14.3%
Total		49	100.0%

Current practices		SDA-1	DA-2	N-3	A-4	SA-5	Total
The organization has construction equipment management principles and guidelines	Frequency	5	21	15	8	0	49
	Percent	10.2%	42.9%	30.6%	16.3%	0.0%	100.0%
The organization has Equipment hiring and purchasing schedule	Frequency	23	9	10	2	5	49
	Percent	46.9%	18.4%	20.4%	4.1%	10.2%	100.0%
The organization has structured construction equipment administration and maintenance	Frequency	14	5	10	12	8	49
	Percent	28.6%	10.2%	20.4%	24.5%	16.3%	100.0%

support process							
The organization has well staff capacity maintenance and their effectiveness on the construction equipment	Frequency	2	15	12	19	1	49
	Percent	4.1%	30.6%	24.5%	38.8%	2.0%	100.0%
The organization owns skilled equipment operator	Frequency	11	7	9	20	2	49
	Percent	22.4%	14.3%	18.4%	40.8%	4.1%	100.0%
The organization has capable drivers and operators	Frequency	7	2	21	19	0	49
	Percent	14.3%	4.1%	42.9%	38.8%	0.0%	100.0%
The organization has good equipment management practice	Frequency	29	13	4	2	1	49
	Percent	59.2%	26.5%	8.2%	4.1%	2.0%	100.0%
The organization has scheduled equipment upgrading and disposing system	Frequency	25	16	4	2	2	49
	Percent	51.0%	32.7%	8.2%	4.1%	4.1%	100.0%
The equipment allocation system of the organization is clear and scheduled	Frequency	19	16	9	2	3	49
	Percent	38.8%	32.7%	18.4%	4.1%	6.1%	100.0%
All the lots of the organization has their own garage office for simple maintenance of equipment'	Frequency	5	34	2	6	2	49
	Percent	10.2%	69.4%	4.1%	12.2%	4.1%	100.0%

Factors that affect equipment management practice		**strongly dis agree (1)**	**dis agree (2)**	**neutral (3)**	**agree (4)**	**strongly agree (5)**	**Total**
Equipment policy related							0
AACRA has written standards, guidelines and manuals procedures to manage construction equipment		5	16	16	7	5	49
AACRA Manuals, standards and procedure are clear and easily understandable		2	19	13	11	4	49

Equipment investment related							0
AACRA Construction equipment investment proposal is initiated at head office by core processes		0	7	24	18	0	49
Both qualitative and quantitative evaluation is adopted to analyze investment proposal.		0	11	22	16	0	49
Equipment selection related				0	1	0	1
AACRA uses internally developed technical and financial criteria		0	3	18	22	6	49
AACRA uses standardization of construction equipment Least price criteria		0	2	18	18	10	48
AACRA uses Past experience and information from another user		0	1	18	26	3	48
Equipment maintenance related							0
The organization has well organized and integrated maintenance system		1	10	11	22	5	49
The organization uses clear and standard criteria		3	10	16	20	0	49
Corrective type of maintenance is undertaken in the organization		0	6	14	21	8	49
Preventive type of maintenance is undertaken in the organization		5	8	11	14	10	48
Equipment replacement related							0
The organization makes economic analysis to replace equipment		8	13	15	10	3	49
The organization replaces equipment when they are inefficient		8	8	9	20	4	49
The organization replaces old equipment before new project is		9	10	20	7	2	48

hand over							
The organization replaces equipment before major overhaul		6	10	17	16	0	49
The organization disposes construction through third party		5	4	15	21	3	48
Equipment benefit standardization related							0
Standardizations can bring better performance of the organization		0	3	16	17	13	49
Standardizations can make ease for construction equipment management issues		0	4	14	12	18	48
Standardizations can lower maintenance costs		0	5	11	17	16	49
Equipment record keeping related							0
There is an appropriate method of data recording		2	8	10	20	9	49
Equipment utilization record is properly maintained both at head office and projects		1	6	12	26	4	49
Construction equipment costs are recorded properly		3	10	8	20	7	48
Maintenance data and costs are recorded properly		1	7	14	18	9	49
Equipment monitoring and controlling related							0
The organization has construction equipment inventory system.		6	5	11	18	9	49
The organization equipment inventory system is effective and efficient		2	6	21	18	1	48

The organization has monitoring and controlling mechanism to evaluate performance of equipment.		2	7	17	20	3	49
The organization has effective and efficient monitoring and controlling mechanism to evaluate performance of equipment		2	11	21	14	1	49
Equipment management challenges related							0
The high cost of construction equipment management system		0	15	18	11	5	49
Not Availabil of skilled manpower in the construction equipment management system		1	13	13	17	5	49

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Gender	49	1.00	2.00	1.2857	.45644
Organization	49	1.00	2.00	1.2041	.40721
J_Position	49	1.00	3.00	2.4286	.76376
E_Background	49	2.00	3.00	2.2245	.42157
W_Experience	49	1.00	4.00	2.6327	.78246
Valid N (listwise)	49				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EP1	0				
EP2	49	1.00	5.00	2.8163	1.13051
Valid N (listwise)	0				

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
EP1	49	1.00	5.00	2.8163	1.13051
EP2	49	1.00	5.00	2.8163	1.13051
Valid N (listwise)	49				

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
EI1	49	1.00	5.00	2.9184	1.05745
EI2	49	2.00	4.00	3.1020	.74288
Valid N (listwise)	49				

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
ES1	49	2.00	4.00	3.2245	.68512
ES2	49	2.00	4.00	3.1020	.74288
ES3	49	2.00	5.00	3.6327	.78246
Valid N (listwise)	49				

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
EM1	49	2.00	5.00	3.7755	.84817
EM2	49	2.00	5.00	3.6735	.65789
EM3	49	1.00	5.00	3.4082	.99830
EM4	49	1.00	4.00	3.0816	.93177
Valid N (listwise)	49				

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
ER1	49	2.00	5.00	3.6327	.90586
ER2	49	1.00	5.00	3.3673	1.28604

ER3	49	1.00	5.00	2.7347	1.15064
ER4	49	1.00	5.00	3.0816	1.25560
ER5	49	1.00	5.00	2.6735	1.08758
Valid N (listwise)	49				

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
EB1	49	1.00	4.00	2.8776	1.01309
EB2	49	1.00	5.00	3.3061	1.08405
EB3	49	2.00	5.00	3.8163	.90539
Valid N (listwise)	49				

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
EK1	49	2.00	5.00	3.9388	1.00847
EK2	49	2.00	5.00	3.8980	.98414
EK3	49	1.00	5.00	3.5306	1.10117
EK4	49	1.00	5.00	3.5306	.89214
Valid N (listwise)	49				

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
EC1	49	1.00	5.00	3.4082	1.17115
EC2	49	1.00	5.00	3.5510	1.02187
EC3	49	1.00	5.00	3.3878	1.25526
EC4	49	1.00	5.00	3.2449	.87870
Valid N (listwise)	49				

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
EMC1	49	1.00	5.00	3.3061	.93995
EMC2	49	1.00	5.00	3.0204	.87773
Valid N (listwise)	49				

Correlations			
		EP1	EP2
EP1	Pearson Correlation	1	1.000**
	Sig. (2-tailed)		.000
	N	49	49
EP2	Pearson Correlation	1.000**	1
	Sig. (2-tailed)	.000	
	N	49	49
**. Correlation is significant at the 0.01 level (2-tailed).			

Correlations					
		EP1	EP2	EI1	EI2
EP1	Pearson Correlation	1	1.000**	.946**	.841**
	Sig. (2-tailed)		.000	.000	.000
	N	49	49	49	49
EP2	Pearson Correlation	1.000**	1	.946**	.841**
	Sig. (2-tailed)	.000		.000	.000
	N	49	49	49	49
EI1	Pearson Correlation	.946**	.946**	1	.859**
	Sig. (2-tailed)	.000	.000		.000
	N	49	49	49	49
EI2	Pearson Correlation	.841**	.841**	.859**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	49	49	49	49
**. Correlation is significant at the 0.01 level (2-tailed).					

Correlations										
		EP1	EP2	ES1	ES2	ES3	EM1	EM2	EM3	EM4
EP1	Pearson Correlation	1	1.000**	.834**	.841**	.935**	.934**	.870**	.898**	.825**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49
EP2	Pearson Correlation	1.000**	1	.834**	.841**	.935**	.934**	.870**	.898**	.825**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49
ES1	Pearson Correlation	.834**	.834**	1	.896**	.779**	.806**	.721**	.808**	.884**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49
ES2	Pearson Correlation	.841**	.841**	.896**	1	.783**	.831**	.752**	.870**	.891**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49
ES3	Pearson Correlation	.935**	.935**	.779**	.783**	1	.909**	.895**	.916**	.842**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49
EM1	Pearson Correlation	.934**	.934**	.806**	.831**	.909**	1	.874**	.873**	.841**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000

	N	49	49	49	49	49	49	49	49	49
EM2	Pearson Correlation	.870**	.870**	.721**	.752**	.895**	.874**	1	.905**	.792**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000
	N	49	49	49	49	49	49	49	49	49
EM3	Pearson Correlation	.898**	.898**	.808**	.870**	.916**	.873**	.905**	1	.882**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.000
	N	49	49	49	49	49	49	49	49	49
EM4	Pearson Correlation	.825**	.825**	.884**	.891**	.842**	.841**	.792**	.882**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	
	N	49	49	49	49	49	49	49	49	49
**. Correlation is significant at the 0.01 level (2-tailed).										

Correlations

		EP1	EP2	ER1	ER2	ER3	ER4	ER5	EB1	EB2	EB3
EP1	Pearson Correlation	1	1.000**	.930**	.921**	.955**	.877**	.916**	.871**	.880**	.923**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
EP2	Pearson Correlation	1.000**	1	.930**	.921**	.955**	.877**	.916**	.871**	.880**	.923**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
ER	Pearson Correlation	.930**	.930**	1	.923**	.924**	.906**	.933**	.903**	.902**	.907**

1	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
ER2	Pearson Correlation	.921**	.921**	.923**	1	.926**	.936**	.922**	.931**	.934**	.918**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
ER3	Pearson Correlation	.955**	.955**	.924**	.926**	1	.924**	.945**	.901**	.902**	.932**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
ER4	Pearson Correlation	.877**	.877**	.906**	.936**	.924**	1	.920**	.925**	.946**	.875**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
ER5	Pearson Correlation	.916**	.916**	.933**	.922**	.945**	.920**	1	.889**	.899**	.911**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49
EB1	Pearson Correlation	.871**	.871**	.903**	.931**	.901**	.925**	.889**	1	.888**	.906**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.000	.000
	N	49	49	49	49	49	49	49	49	49	49
EB2	Pearson Correlation	.880**	.880**	.902**	.934**	.902**	.946**	.899**	.888**	1	.844**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000		.000
	N	49	49	49	49	49	49	49	49	49	49

EB3	Pearson Correlation	.923**	.923**	.907**	.918**	.932**	.875**	.911**	.906**	.844**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	
	N	49	49	49	49	49	49	49	49	49	49
**. Correlation is significant at the 0.01 level (2-tailed).											

Correlations

		EP1	EP2	EK1	EK2	EK3	EK4	EC1	EC2	EC3	EC4	EMC1	EMC2
EP1	Pearson Correlation	1	1.000**	.867**	.882**	.900**	.863**	.907**	.919**	.903**	.843**	.858**	.865**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49	49	49
EP2	Pearson Correlation	1.000**	1	.867**	.882**	.900**	.863**	.907**	.919**	.903**	.843**	.858**	.865**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49	49	49
EK1	Pearson Correlation	.867**	.867**	1	.938**	.893**	.870**	.904**	.883**	.891**	.887**	.877**	.872**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49	49	49
EK2	Pearson Correlation	.882**	.882**	.938**	1	.897**	.870**	.905**	.886**	.910**	.873**	.868**	.919**
	Sig. (2-	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00	.00

	tailed)	0	0	0		0	0	0	0	0	0	0	0
	N	49	49	49	49	49	49	49	49	49	49	49	49
EK3	Pearson Correlation	.900**	.900**	.893**	.897**	1	.916**	.959**	.957**	.963**	.875**	.907**	.894**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49	49	49
EK4	Pearson Correlation	.863**	.863**	.870**	.870**	.916**	1	.905**	.907**	.910**	.867**	.895**	.837**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49	49	49
EC1	Pearson Correlation	.907**	.907**	.904**	.905**	.959**	.905**	1	.940**	.953**	.852**	.887**	.904**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49	49	49
EC2	Pearson Correlation	.919**	.919**	.883**	.886**	.957**	.907**	.940**	1	.967**	.891**	.905**	.870**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49	49	49
EC3	Pearson Correlation	.903**	.903**	.891**	.910**	.963**	.910**	.953**	.967**	1	.875**	.904**	.881**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000
	N	49	49	49	49	49	49	49	49	49	49	49	49
E	Pearson	.84	.84	.88	.87	.87	.86	.85	.89	.87	1	.94	.88

C4	Correlation	3**	3**	7**	3**	5**	7**	2**	1**	5**		2**	5**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000
	N	49	49	49	49	49	49	49	49	49	49	49	49
EMC1	Pearson Correlation	.858**	.858**	.877**	.868**	.907**	.895**	.887**	.905**	.904**	.942**	1	.876**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000
	N	49	49	49	49	49	49	49	49	49	49	49	49
EMC2	Pearson Correlation	.865**	.865**	.872**	.919**	.894**	.837**	.904**	.870**	.881**	.885**	.876**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	
	N	49	49	49	49	49	49	49	49	49	49	49	49
**. Correlation is significant at the 0.01 level (2-tailed).													

Item Statistics			
	Mean	Std. Deviation	N
CP1	2.5306	.89214	49
CP2	3.4082	1.03920	49
CP3	3.7551	.85466	49
CP4	3.0408	.97808	49
CP5	3.5714	.79057	49
CP6	3.4898	.58175	49
CP7	2.7959	1.02020	49
CP8	3.0612	1.02892	49
CP9	3.0408	1.04002	49

CP10	2.3061	.96186	49
EP1	2.8163	1.13051	49
EP2	2.8163	1.13051	49
EI1	2.9184	1.05745	49
EI2	3.1020	.74288	49
ES1	3.2245	.68512	49
ES2	3.1020	.74288	49
ES3	3.6327	.78246	49
EM1	3.7755	.84817	49
EM2	3.6735	.65789	49
EM3	3.4082	.99830	49
EM4	3.0816	.93177	49
ER1	3.6327	.90586	49
ER2	3.3673	1.28604	49
ER3	2.7347	1.15064	49
ER4	3.0816	1.25560	49
ER5	2.6735	1.08758	49
EB1	2.8776	1.01309	49
EB2	3.3061	1.08405	49
EB3	3.8163	.90539	49
EK1	3.9388	1.00847	49
EK2	3.8980	.98414	49
EK3	3.5306	1.10117	49
EK4	3.5306	.89214	49

EC1	3.4082	1.17115	49
EC2	3.5510	1.02187	49
EC3	3.3878	1.25526	49
EC4	3.2449	.87870	49
EMC1	3.3061	.93995	49
EMC2	3.0204	.87773	49

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.467	.519		-2.824	.010
	EP2	.362	.098	.458	3.703	.001
	EI1	.334	.133	.395	2.499	.021
	ES1	.074	.117	.057	.630	.536
	ES2	.311	.122	.259	2.557	.018
	ES3	.013	.120	.011	.104	.918
	EM1	-.845	.167	-.803	-5.071	.000
	EM2	.019	.220	.014	.086	.932
	EM3	-.270	.122	-.302	-2.219	.038
	EM4	-.193	.145	-.202	-1.327	.199
	ER1	1.058	.132	1.074	7.984	.000
	ER2	.652	.144	.940	4.520	.000
	ER3	-.609	.097	-.786	-6.286	.000
	ER4	.216	.082	.305	2.650	.015
	ER5	-.069	.086	-.084	-.810	.427
	EB1	-1.017	.198	-1.155	-5.133	.000
	EB2	-.673	.129	-.817	-5.202	.000
	EB3	.331	.102	.336	3.244	.004
	EK1	-.068	.082	-.076	-.822	.420

	EK2	.705	.187	.778	3.771	.001
	EK3	-.155	.121	-.191	-1.287	.212
	EK4	-.150	.161	-.150	-.934	.361
	EC1	-.160	.144	-.210	-1.107	.281
	EC2	.302	.102	.346	2.948	.008
	EC3	-.021	.138	-.029	-.149	.883
	EC4	.177	.117	.175	1.514	.145
	EMC1	.803	.087	.846	9.263	.000
	EMC2	-.221	.109	-.218	-2.026	.056
a. Dependent Variable: CP1						