



Addis Ababa University

Addis Ababa Institute of Technology

School of Civil and Environmental Engineering

**Assessment of Performance Measures for Material Management
Process on Building Projects in Addis Ababa**

By: Dawd Abdu (ID No : GSR/3911/05)

A Project Submitted to School of Civil and Environmental Engineering in
Partial Fulfilment of the Requirement for the Degree of Master of
Engineering in Civil Engineering (Construction Technology and
Management Major)

Advisor: Prof.Dr.-Ing. Abebe Dinku

October 2015 GC

Addis Ababa



Addis Ababa University

Addis Ababa Institute of Technology

School of Civil and Environmental Engineering

**Assessment of Performance Measures for Material Management
Process on Building Projects in Addis Ababa**

By: Dawd Abdu (ID No : GSR/3911/05)

A Project Submitted to School of Civil and Environmental Engineering in
Partial Fulfilment of the Requirement for the Degree of Master of
Engineering in Civil Engineering (Construction Technology and
Management Major)

October 2015 GC

Approved By:

Advisor: Prof.Dr.-Ing Abebe Dinku

Signature: _____

Date: _____

Examiner: _____

Signature: _____

Date: _____

ACKNOWLEDGMENT

First of all, I would like to thank my advisor Prof. Dr. –Ing. Abebe Dinku for his valuable advice.

I would also like to thank everybody who cooperate and support me while conducting this study .I would like to give special thanks to Ato Mekonen Besha, Ato Getenet Tilahun and Ato Diriba Defersha.

ABSTRACT

One of the problems which face the construction industry of Addis Ababa is poor construction material management. Studies show that construction material covers around 60% of the project cost. Construction materials hold a major part for the profitability and effectiveness of the construction project. Identifying performance measures for material management help for effective management of the construction project. This study identifies the usability, importance and practicality of the selected 26 performance measures for material management on building projects in Addis Ababa. Based on this research the top three important performance measures are material availability, material wastage and construction time lost and the top three practical performance measures are total surplus, materials receipt problems and procurement lead –time. From the selected 26 performance measures Only 4 performance measures used on building projects in Addis Ababa.

Table of Contents

ACKNOWLEDGMENT.....	i
ABSTRACT.....	ii
LIST OF TABLE S.....	vi
LIST OF FIGURES.....	vii
ABBREVIATIONS.....	viii
CHAPTER ONE.....	1
1. INTRODUCTION.....	1
1.1 Back Ground.....	1
1.2 Scope of Study.....	3
1.3 Study Objective.....	3
1.4 Methodology.....	4
1.5 Steps of Conducting the Project.....	4
CHAPTER TWO.....	7
2. LITERATURE REVIEW.....	7
2.1 Definition of Material Management.....	7
2.2 Material Management Functions.....	8
2.2.1 Material planning.....	8
2.2.2 Purchasing.....	9
2.2.3 Receiving.....	10
2.2.4 Storing.....	10
2.2.5 Transporting.....	12
2.3 Advantages of Construction Material Management.....	13
2.3.1 Reduce excessive surplus material.....	13
2.3.2 Reduce manpower on material management.....	13
2.3.3 Labor productivity improved.....	14
2.3.4 Improve cash flow system.....	14
2.3.5 Reduce the overall cost of material.....	14
2.3.6 Good material handling.....	15
2.3.7 Reduce duplicated order.....	15
2.3.8 Improve the accomplishment of the project plan.....	15
2.3.9 Quality of material improved.....	16

3.3.10 Relationship with supplier improved.....	16
3.4 Material Management Problems.....	16
CHAPTER THREE.....	20
3. PERFORMANCE MEASURES.....	20
3.1 Background.....	20
3.2 Measures Adopted from Plemmons (1995).....	20
3.2.1 Material receipt problems:.....	21
3.2.2 Warehouse inventory accuracy:.....	21
3.2.3 Head office requisition percentage:.....	21
3.2.4 Head office Purchase Order percentage:.....	21
3.2.5 Sole source purchases:.....	22
3.2.6 Minority suppliers:.....	22
3.2.7 Procurement leads time:.....	22
3.2.8 Bid-Evaluate-Commit lead time:.....	22
3.2.9 Purchase Order to material receipt duration:.....	22
3.2.10 Material receiving processing time:.....	23
3.2.11 Commodity vendor timeliness:.....	23
3.2.12 Commodity timeliness:.....	23
3.2.13 Materials withdrawal request lead time:.....	23
3.2.14 Materials withdrawal request processing time:.....	24
3.2.15 Average man-hour per purchase order:.....	24
3.2.16 Freight cost percent:.....	24
3.2.17 Construction time lost:.....	25
3.2.18 Min/Max release from warehouse:.....	25
3.2.19 Warehouse safety incident rate:.....	25
3.2.20 Total surplus:.....	25
3.2.21 Material availability:.....	25
3.2.22 Backorders:.....	26
3.3 Designed performance measures.....	26
3.3.1 Material wastage.....	26
3.3.2 Purchase from foreign country.....	26
3.3.3 Discount from bulk purchase.....	26

3.3.4 Budget availability.....	27
CHAPTER FOUR	28
4. DATA COLLECTION AND ANALYSIS.....	28
4.1 Background	28
4.2 Questionnaires Design	28
4.3 Data Analysis.....	30
4.4 Interview Response Rate	30
4.5 Respondent Profile and Grade of the Company of the Respondent	32
4.6 Extent of Material Management Problem	33
4.7 Performance Measures Usage.....	34
4.8 Importance of the Performance Measures	37
4.9 Practicality of the Performance Measures	40
CHAPTER FIVE	44
5. CONCLUSIONS AND RECOMMENDATIONS.....	44
5.1 Conclusions	44
5.2 General Recommendation	44
5.3 Recommendation for Further Study.....	45
REFERANCE	46
APPENDIX:.....	47

LIST OF TABLE S

Table 4.1 Summary of interview response rate	Page 31
Table 4.2 Performance measures usage rating	Page 35
Table 4.3 Importance of proposed performance measures	Page 38
Table 4.4 Practicality of proposed performance measures	Page 41

LIST OF FIGURES

Figure 1.1 Flow chart of research methodology	Page 6
Figure 4.1 Five ordinal measures of agreement.....	Page 29
Figure 4.2 Interview response rate	Page 31
Figure 4.3 Experience of the respondents	Page 32
Figure 4.4 Grade of the companies of the respondent	Page 33
Figure 4.5 Poor construction material management problem extents	Page 34
Figure 4.6 Top 5 important performance measures	Page 40
Figure 4.7 Top 5 practical performance measures	Page 43

ABBREVIATIONS

ASCE American Societies of Civil Engineers

BC Building Contractor

GC General Contractor

RI Relative Index

Eqn. Equation

CHAPTER ONE

1. INTRODUCTION

1.1 Back Ground

Construction industry is a huge sector which has great contribution for the development of the country specially the developing one like our country Ethiopia. Most of the capital budget of the developing country is goes to for the construction of infrastructures because the development of infrastructure is the back bone of the economic growth of the country. This huge sector faces different type of debatable problem. Poor construction material management is one of the debatable issues between the parties which involved in the construction industry.

It is known fact that, resource planning and management is one the most important parameters for competitiveness and profitability in today's construction technology .One important aspect of resources management is management of construction material in construction projects [1].

Material management is defined as the management system for planning and controlling all the necessary efforts to ensure that the right quality and quantity of materials and installed equipments are appropriately specified in a timely manner ,and obtained at a reasonable cost, and are available when needed .Especially, management of construction materials is generally recognized to be the integrated coordination of materials takeoff ,purchasing ,expediting ,receiving, ware housing, proper utilization and disposal. When these functions are not properly managed, material shortages, surpluses, and cash flow

problems are likely to occur. Costly labor delays result when the required quantity and quality of construction materials are not available when needed [2].

Material cost covers around 60 percents of the project cost. According to the research done in Ethiopia the construction materials constitute 57 percent of the total budget allocated for construction work [9]. Since material cost of the project covers large portion of the project cost, improvement on material management will result great improvement on the overall construction project.

When poor construction material management occur , numerous non value-adding activities or costs are likely to arise. These include unplanned site meetings, travelling and communication expenses, idle plant and labor during the waiting time, etc. These represent a waste of resources and are typically paid for by the contractor. Therefore, the construction material management system should be improved to the good level.

Previously done thesis's related to material management in Addis Ababa University is very few relative to its importance. The writer interested to study assessment of performance measures for material management process on building construction projects because the construction material hold the major cost of the building projects, the result of the research will serve for the parties involved in the construction sector (contractors, consultants, clients ,etc) to properly measure the performance of construction material management process and to improve the construction material management process based on the measurement and to serve as a reference for future research related to construction material management.

The scope of the research is limited to building projects in Addis Ababa due to time and financial constraints. Considering the time and financial situation on the future I might develop the area of coverage of the research to building projects in Ethiopia.

1.2 Scope of Study

The study will be confined to the building construction projects because in this type of construction projects construction material holds major cost of the project rather than equipment and labor cost. Because of finance and time, this study is limited on building projects in Addis Ababa. This study assesses the performance measure of construction material management process on building projects from contractors' point of view.

1.3 Study Objective

The objective of the study is to:

- ✓ Identify the performance measures used for material management on building projects in Addis Ababa.
- ✓ Identify the importance of the performance measures in assessing the effectiveness of the material management process.
- ✓ Identify the practicability of implementation of performance measures on building projects in Addis Ababa.

1.4 Methodology

The study start from identification of performance measures for material management process from literature review, site visit, head office visit, and interviews with concerned professionals.

Whenever there is unclear primary data or ambiguity, further explanation or information obtained through interviews with concerned bodies in order to maximize the clarity and to gain adequate understanding of the data.

Then questionnaire designed based on the information collected to measure performance of material management process.

The sample size identified to decide the amount of professionals interviewed. The interview conducted by using simple random sampling in order to get representative sample. Ten professionals interviewed who work on construction projects which are found on ten sub city of Addis Ababa.

Analysis and discussion followed based on the collected data. Finally, conclusions drawn and recommendation forwarded based on the finding of the study and reviewed literature.

1.5 Steps of Conducting the Project

Step 1: Literature review and at the same time design question for interview .

Step 2: Conduct interview, construction site and head office visit.

Step 3: Analyzing the response from interview, construction site and head office visit.

Step 4: Design questionnaire and interview conducted based on the questionnaire.

Step 5: The response analyzed.

Step 6: Conclusion and recommendation of the project forwarded.

In short I followed the following flow chart to conduct the study

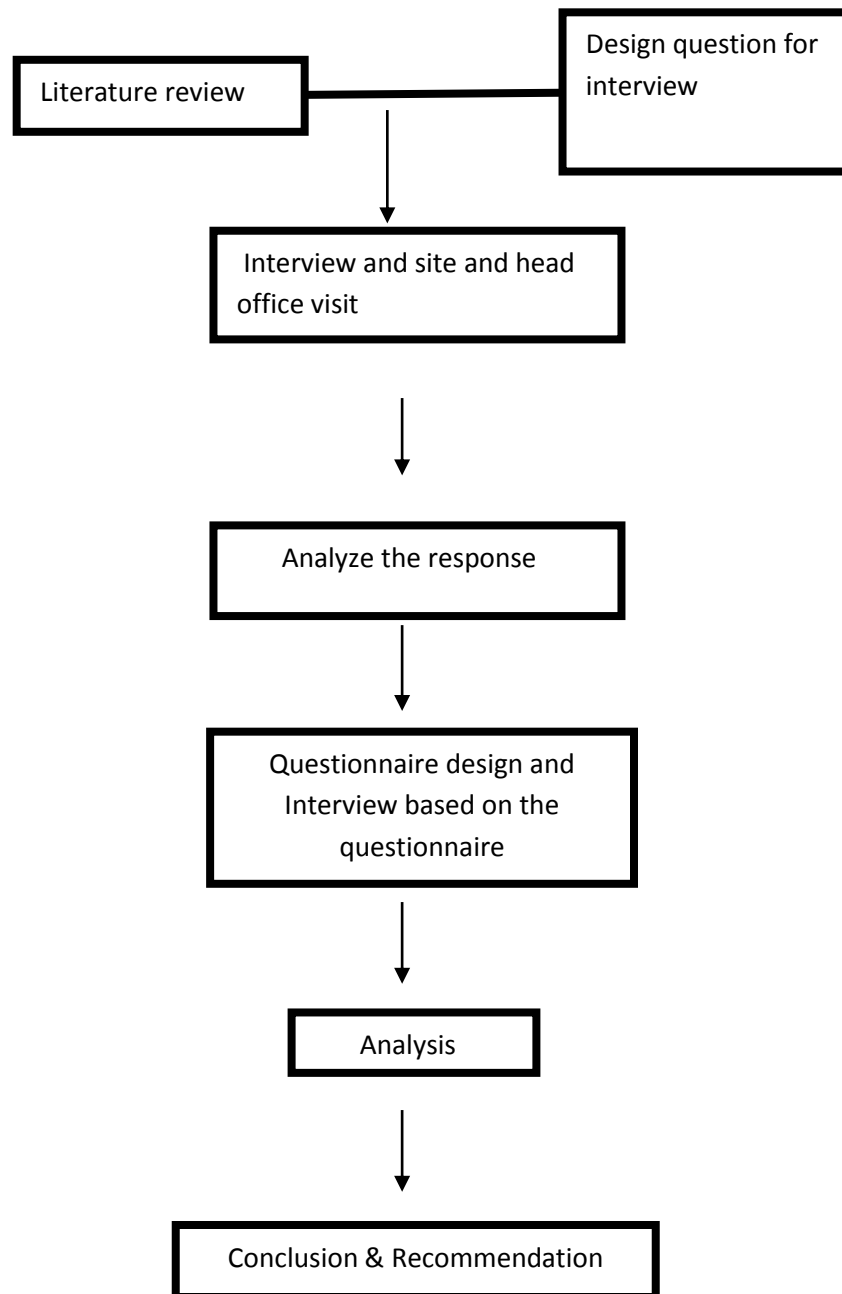


Figure 1.1 Flow chart of research methodology

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Definition of Material Management

There is no single definition of material management. Various books deferent scholars define material management in different ways.

According to the definition of business dictionary ,material management is “The planning and control of the functions supporting the complete cycle (flow) of materials, and the associated flow of information. These functions include (1) identification, (2) cataloging, (3) standardization, (4) need determination, (5) scheduling, (6) procurement, (7) inspection, (8) quality control, (9) packaging, (10) storage, (11) inventory control, (12) distribution, and (13) disposal [3].”

Management dictionary /MBA dictionary defines material management as follows “Materials management is a group of organizational functions responsible for the planning ,sourcing ,stocking, manufacturing ,control and distribution activities of material used in the internal and external fulfillment of demand. Typically the term includes all logistical activities that control the transmission of tangible, physical materials through the value chain such as shipping and transport, distribution and warehousing, quality control, work in progress and manufacturing [5].”

The material management system of different company might be different but the main objective of material management is to deliver the right quantity and quality of material at the right place from the right source at the right price and time.

Material management has different process like material planning, requisition, procurement, purchasing, storing, delivery, etc

2.2 Material Management Functions

Material management covers starting from material planning up to consumption of the material. The major functional area of material management includes material planning, purchasing, receiving, storing and transporting.

2.2.1 Material planning

Material plan is a plan which describes the quantity and type of material which used for the construction and when it will be used. The quantity of the required material identified from the bill of quantity and the drawing. The material requirement duration or time depend on the starting date of the construction project , the contract time of the project and the available resource for the completion of the work. Material management planning is the back bone of material management because every successor activities depend on it which means in order to have good material management the material planning should be good.

Based on the material plan the engineering staff passes the requisition to the store team then the store team check the availability of the material in the store if available it will be

delivered as per the plan if not it will be passed to purchasing team in order to be purchased.

2.2.2 Purchasing

Purchasing is a process of buying material or service based on the request of other team of the company. Profitability of the construction company mainly depends on the efficiency of the purchasing system since the construction material covers most of the cost of the project around 60 percent of the whole project cost. If we able to minimize the material purchasing cost by applying efficient material purchasing system without compromising the quality of the material and on time delivery of the material, we can maximize the profit highly since material cost covers the major cost of the project.

During the material purchasing process the following activity should be done appropriately:

- Best suppliers selected based on their capacity, previous performance, honesty or other criteria.
- Enough number of suppliers should be selected to create good competition.
- The procurement process should be done carefully in order to get good quality material by a reasonable cost.
- The quality of material should be checked by the right professional before purchased.
- The decision to purchase or not purchase the material should be done by managerial level because the purchasing process is very vulnerable to corruption.
- The material should be delivered as per the plan of the project.

- We should keep good relationship with the suppliers for future purchase and any necessary assistance.

2.2.3 Receiving

Material receiving is a process of getting the purchased materials which are previously requested. During the material receiving process the professional who receive the material should check the following things.

- Whether the material is the requested one or not.
- The quality of the material
- The quantity of the material
- The material handling information, if available.

2.2.4 Storing

As described earlier one of the objective of material management is to deliver the right quality of material with the right quantity at the right time .In order to fulfill this objective we need storage to deliver material when needed. The purchased material should be stored before some duration before needed for the work to keep the continuity of the work. We should keep balance between the storage cost and stock out cost. If we purchase too much material and stock it, in addition to capital tie up or cash flow disturbance there will be storage, protection, obsolescence and some other risk costs. On other way if we keep the inventory level low or null, there will be idle and delay cost because the labor and equipments stop work since they get shortage of material to do the work.

While we store material proper attention should be given according to the type of material .For example first in material should be first out by proper space area arrangement, cement should not be placed directly on the floor to escape the moisture from the floor, Rebar should be placed moisture free area to keep from corrosion, Some material like water heater need to be placed by keeping the up side up, thin material like glass ,ceramic ,terrazzo, etc should be place vertically to keep from easy breakage .

The federal democratic republic of Ethiopia cooperative agency material management training material for cooperative promoter describes the objective and principle of material storage as follows [7]:

- Objectives:
 1. Prevention of waste and/or misappropriation of materials
 2. Reduced need for material handling equipment
 3. Provision of better storage facilities.
 4. Ready accessibility of major materials permitting efficient service to users.
 5. Awareness of limited shelf-life items with a view to stock turnover in time to prevent deterioration.
 6. Efficient space utilization and flexibility of arrangement.
 7. To make available a balanced flow of raw materials, components tools, equipments and any other items necessary to meet the production requirements.
 8. To maintain sufficient stock of materials to level out irregularities of procurement.
 9. Reduction in need of materials handling equipments
 10. To offset delays in transportation, provide easy location and quick identification of items.

11. To add flexibility to production schedules.
12. Permit quantity purchases at comparatively lower prices
13. To maintain efficient quantity records of movement of stock and to account for all goods that is kept in stores.
14. To prevent any theft, damage, wastage or deterioration of stored items.

- Principles:

1. All the materials must be identified, labeled and coded properly. When material codification is accompanied by location codes, it facilitates exact location of the materials inside the storeroom.
2. All the bins, racks, shelves etc. must have signs and tags attached to them.
3. Materials should be stored at proper safe place to prevent these from damage and mishaps.
4. Each item stored must bear name, class and reference number. It helps in easy, quick identification. It eliminates chances of duplication of items likely to be presented under different names. It also helps in standardization and reducing the variety of the materials.
5. Floor plan must be provided at convenient places in storeroom. It eliminates waste of time and helps in easy location of material.
6. The storeroom should be divided into sections and materials belonging to particular class should be stored in it.

2.2.5 Transporting

Material transportation is the process of moving material from one place to other place through different transportation mechanism like vehicle, ship, plane, etc. The

construction material should be transferred to the construction site as per the planned time safely with a reasonable cost. In order to transport the material safely we should follow the material handling information because if the delivered material is broken or rotten it is similar to material undelivered because the progress of the work stopped due to shortage of material.

2.3 Advantages of Construction Material Management

Effective construction material management has so many advantages to the project. Some of the main advantages discussed as follows:

2.3.1 Reduce excessive surplus material

The application of effective construction material management enforced the professional who request the material to request the material exactly needed to the work by applying appropriate quantity surveying and considering appropriate wastage instead of simple guess or random construction material delivery. The professional should also follow the exact application of the material.

2.3.2 Reduce manpower on material management

The application of effective construction material management reduces the no of man power on material management by avoiding or cutting the unnecessary steps in construction material management and well trained professionals can cover a lot of work effectively.

3.3.3 Labor productivity improved

Effective construction material management improves labor productivity by training, reducing idle time, reward and punishment. Regular and continuous training make the labors knowledgeable to do the work expected from them effectively. Idle time due to material supply delay decreased by application of good construction material management system which lead to the improvement of labor productivity. Rewarding the labor who perform good and punishing the labor that perform bad, teaches the labor to perform good to get reward and not to perform bad to escape punishment.

3.3.4 Improve cash flow system

One of the criteria for healthy cash flow is effective construction material management. Because if we able to have effective construction material management system, money will not tied up by purchasing of surplus materials or materials which are not used at the right time. The materials purchasing have done by considering the cash flow and the material schedule.

3.3.5 Reduce the overall cost of material

Effective construction material management can reduce the overall cost of material by

- Application of bulk purchase
- Purchasing good quality material, which avoid additional purchase
- Avoiding repetitive purchase
- Minimizing deterioration of material ,etc

3.3.6 Good material handling

By the application of effective construction material management system, we can improve material handling since we follow material handling instructions. Material handling can be improved by following proper storage and transportation instruction. During material transportation we should strictly follow the transportation instruction for example some thin materials like glass, terrazzo, marble, ceramics, etc need to be placed vertically on vehicles to keep from breakage. We should also strictly follow material storage instruction .Some material needs special precaution for example cement should not be placed directly on the floor because moisture from the floor can result pre setting of cement.

3.3.7 Reduce duplicated order

When the requested material not delivered on time or delays too much, the material requisition form may disappear or even the requested material may be forgotten. This problem may lead to duplicated order. In addition to this if we cannot have well categorized data system to identify the purchased materials from the not purchased materials; duplicated order may result at the end. This duplicated order can be minimized by the application of effective construction material management system.

3.3.8 Improve the accomplishment of the project plan

Effective construction material management system of the company will deliver the required material to the project as per the required time and quality. At the result of this the progress of the project not interrupted by shortage of material and idle time is

minimized or avoided. Therefore, the project could be completed on time or earlier if it is not interrupted by other factors.

3.3.9 Quality of material improved

Effective construction material management system of the company has qualified professionals to control the quality of the material before the material purchasing process completed. These professionals help to keep the quality of the project work and minimize reworks due to the usage of poor quality material. In addition to the work quality improvement, extra cost from rework minimized.

3.3.10 Relationship with supplier improved

Effective construction material management systems of the company have well organized data from the previous purchase or other source about suppliers for future purchasing activity. When the company need to purchase material first check the history of the company from the previous purchase data or from other source whether it is in good list or black list .if it is in good list the hesitation minimized and the relationship improved well.

If the company has effective construction material management system not only keep the right of the company itself but also keeps the right of the suppliers like by giving payment on time, by taking the purchased material on time , etc for better relationship.

3.4 Material Management Problems

Construction material management covers large part of the construction project management since material covers around 60% percent of the project cost and the

building construction need so many different types of materials. This wide area of management faces different problems.

Some of the most common challenges of the construction material management described as follows:

- **Ordering in Excess**

Cash flow is the key aspect in running a construction management company. Ordering and storing excess material might tie up the cash flow and also incur interest charges for the business [4]. There is also additional expenses for excess material like storage cost, transportation cost (if transferred to other construction site), and risk of theft, obsolescence, etc. The necessary material of the project should be quantified by quantity surveyor or office engineer and also should be checked by the right professional before the material purchased because sometimes excess material purchased because of wrong quantity surveying of unqualified professional.

- **Unavailability of storage space**

When products are purchased in excess volume, lack of storage space results in loss of materials due to damage and theft [4]. Specially most of the construction projects found in the city faces difficulty of storage space even it is difficult to get rental store around the construction site. This problem results difficulty on material handling because the unavailability of storage space lead the material to be stored on scattered manner which make the material supply to take more time.

- **Unorganized storage**

This leads to wastage of labor efforts and time, searching the materials when needed [4]. If the material stored in unorganized manner, it takes too much time for searching the material even we may not get it although it is available in the store. The store should be well organized by placing the material according to the material type and category. The information about the stored material should be placed or posted on visible spaces in order to be easily understood.

- **Wrong quality or type of materials**

The quality and type of material should be check by right professional otherwise serious problem may occur. Purchase and storage of the wrong quality of material, results in re-work demanding labor force efforts and time [4].

- **Not ordering on time**

Inadequate training in handling materials and not keeping track of the material used, leads to miss out on ordering the materials. This in turn leads to delay in supply and thus a delay in project delivery [4]. All necessary material of the project should be requested by keeping the essential lead time to minimize the occurrence of delay by shortage of material and rush purchasing which may result extra cost.

- **Double handling of material**

This occurs as a result of inadequate materials when required. The process not only involves wastage of time and thus a delay in delivery of the project, but also plays a vital

role in the extending the budget due to surplus transmission of materials [4].The budget management problem may also result this problem. The necessary material of the project carefully identified by the right professional and the necessary budget should be allocated to minimize this problem. The professionals involved on material management works should be aware of this problem.

CHAPTER THREE

3. PERFORMANCE MEASURES

3.1 Background

Performance measurement describes the feedback or information on activities with respect to meeting customer expectations and strategic objectives [8].

Performance measures used to identify the strong and weak side of the management system which is very helpful to improve the effectiveness of the company. The development of the performance measures for construction material management help to measure the effectiveness of the construction material management on construction projects. The performance measurement of the construction material management used to develop bench mark and to improve the efficiency based on the measured bench mark.

Plemmons (1995) research identifies 35 performance measures and six attributes by visiting the site and literature survey. The six attributes are accuracy, quality, quantity, timeliness, cost, and availability[6]. I adopt 22 performance measures out of his 35 performance measures which are suitable for my project. The additional 4 performance measures developed from interview with senior professionals, my experience and literature review.

3.2 Measures Adopted from Plemmons (1995)

The definition and the category of the attribute of the performance measures adopted from plemmons will be presented as follows.

3.2.1 Material receipt problems:

Material receipt problem is the discrepancy of information or data which results inaccuracy on material management. For example, accepting 4mm thick ceramic while the ordered ceramic is 6mm thick.

Attribute: Accuracy

3.2.2 Warehouse inventory accuracy:

Warehouse inventory accuracy measures the correctness of the inventory data in the warehouse. This measure shows if there is discrepancy between the registered data and the existing material in the warehouse.

Attribute: Accuracy

3.2.3 Head office requisition percentage:

Head office requisition percentage measures the percentage of materials request by head office from the whole material request during some particular period of time.

Attribute: Quantity

3.2.4 Head office Purchase Order percentage:

Head office purchase order percentage measures the percentage of materials purchased by head office from the whole material purchased during some particular period of time.

Attribute: Quantity

3.2.5 Sole source purchases:

Sole source purchases measure the percentage of purchases from the sole source to the total purchase amount.

Attribute: Quantity

3.2.6 Minority suppliers:

Minority suppliers measure the percentage of supplies by minority supplier to the total supplier.

Attribute: Quantity

3.2.7 Procurement leads time:

Procurement leads time measures the percentage of the actual procurement leads time to the planned procurement leads time.

Attribute: Timeliness

3.2.8 Bid-Evaluate-Commit lead time:

Bid-Evaluate-Commit lead time means the time taken to bid, evaluate and commit the material. Bid-Evaluate-Commit lead time measures the percentage of the actual Bid-Evaluate-Commit lead time and the planned Bid-Evaluate-Commit lead time.

Attribute: Timeliness

3.2.9 Purchase Order to material receipt duration:

Purchase order to material receipt duration means a duration between the purchase order and the material receipt. Purchase order to material receipt duration measures the

percentage of the actual purchase order to material receipt duration to planned purchase order to material receipt duration.

Attribute: Timeliness

3.2.10 Material receiving processing time:

Material receiving processing time measures the percentage of actual material receiving processing time to planned material receiving processing time.

Attribute: Timeliness

3.2.11 Commodity vendor timeliness:

Commodity vendor timeliness measures the percentage of the vendors who deliver material on time or before the promised delivery time to the total number of vendors who deliver material per specific period of time.

Attribute: Timeliness

3.2.12 Commodity timeliness:

Commodity timeliness measures the percentage of delivered material on time or before the promised delivery time to the total number of delivered material per specific period of time.

Attribute: Timeliness

3.2.13 Materials withdrawal request lead time:

Material withdrawal request lead time measures the percentage of actual material withdrawal request lead time to the planned material withdrawal request lead time. This

performance measurement occurs between the construction team and the warehouse function.

Attribute: Timeliness

3.2.14 Materials withdrawal request processing time:

Material withdrawal request processing time measure the percentage of actual material withdrawal request processing time to the planned material withdrawal request processing time.

Attribute: Timeliness

3.2.15 Average man-hour per purchase order:

Average man-hour per purchase order measure the percentage of actual man-hour per purchase order to the planned average man-hour per purchase order.

Attribute: Cost

3.2.16 Freight cost percent:

Freight cost percent measures the percentage of the transport cost of the material per kilometer to a unit cost of the material.

Attribute: Cost

3.2.17 Construction time lost:

Construction time lost measure the percentage of the time lost due to late delivery or undelivered material to the project contract time.

Attribute: Cost

3.2.18 Min/Max release from warehouse:

Min/Max release from warehouse measures the amount of minimum or maximum material amount released from the store in Birr during some duration.

Attribute: Cost

3.2.19 Warehouse safety incident rate:

Warehouse safety incident rate measures the amount of material lost or stolen from the store per some specified period.

Attribute: Cost

3.2.20 Total surplus:

Total surplus measures the percentage of quantity of surplus material to the whole material quantity.

Attribute: Cost

3.2.21 Material availability:

Material availability measures the percentage of material delivered and available for use to the requested material.

Attribute: Availability

3.2.22 Backorders:

Backorders measure the percentage of backordered material to the required material.

Attribute: Availability

3.3 Designed performance measures

In addition to the adopted performance measures from plemmon (1995), I design some additional performance measures which will be discussed as follows:

3.3.1 Material wastage

Material wastage measures the percentage of material wasted from that particular material.

Attribute: Cost

3.3.2 Purchase from foreign country

Purchase from foreign country measures the percentage of materials purchased from foreign country from the whole purchased material during some specified period.

Attribute: Availability

3.3.3 Discount from bulk purchase

Discount from bulk purchase measures the percentage of the reduced cost from the material cost because of bulk purchase.

Attribute: Cost

3.3.4 Budget availability

Budget availability measures the percentage of the cost of the material which get budget to be purchased without any delay from the whole material purchase cost within some specified period.

Attribute: Availability

CHAPTER FOUR

4. DATA COLLECTION AND ANALYSIS

4.1 Background

To fulfill the objective of the study the data collected from different professional on different building construction site in Addis Ababa in the form of interview based on the developed questionnaire. The developed questionnaire makes easy the analysis of the interviewed data because it is well organized.

The collected data from the interview were analyzed and tabulated according to their ranking on relative index, Bar charts presented from their rating scale.

4.2 Questionnaires Design

Interview survey was carried out to gather information from construction professionals on the issue of construction material management performance measures in addition to detail literature review. The interview survey and literature review was structured to obtain the main objectives of the research. Then the performance measures identified and the questionnaire designed.

The sample of questionnaire used in this study is attached in the Appendix. The questionnaire have three sections: section 1 company and respondent profile, section 2 basic information about construction material management and section 3 questioners of performance measures. The answer of the questionnaire data on section 1 and section 2

filled by me during the interview by writing on the space provided and ticking the box. The answers of the questionnaire data on section 3 are designed based on scale of five ordinal measures of agreement towards each statement (from 1 to 5) as shown in Figure 4.1. The reasons in adopting this simple scale are to be easy for the respondent to answer and to make evaluation of collected data easier to evaluate, and many information can be generated and obtained.

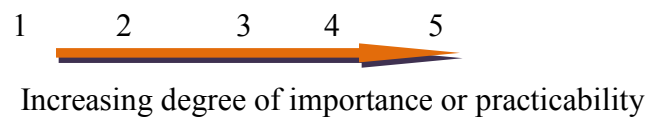


Figure 4.1 Five ordinal measures of agreement

Each scale representing the following rating on importance column

1. Not important
2. Somewhat important
3. Important
4. Very important
5. Extremely important

Each scale representing the following rating on practicality column

1. Not practical
2. Somewhat practical
3. Practical
4. Very practical
5. Extremely practical

4.3 Data Analysis

The collected data were analyzed using the Relative Index methods. Based on the frequency analysis the relative index was then calculated to determine the ranking of each performance measures importance and practicability.

The relative index analysis for variable is calculated by using the formula below:

$$RI = \frac{(5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1)}{5(n_5 + n_4 + n_3 + n_2 + n_1)} \dots\dots\dots [Eqn. 4.1]$$

Where:

RI = Relative Index

n₅, n₄, n₃... = Number of responding indices

The computation of the Relative Index using this formula will yield the value of RI ranging from 0.2 to 1.0. The values 0.2 represent the lowest strength and the value 1.0 representing the maximum strength.

The results of Relative Index are presented on the coming sub chapters by using different forms like tables, pie charts, and bar charts in order to be presented and understand easily.

I used Microsoft Excel software in order to generate the result.

4.4 Interview Response Rate

17 professionals whose works related to material management contacted 4 of them refused for the interview, 3 of them the interviews are aborted and 10 of them successfully interviewed. The detail of the interview response rate summarized on table 4.1 below.

Table 4.1 Summary of interview response rate

S/No	Description	Number	Percentage
1	Successfully interviewed	10	58.82%
2	Aborted interview	3	17.65%
3	Refused interview	4	23.53%

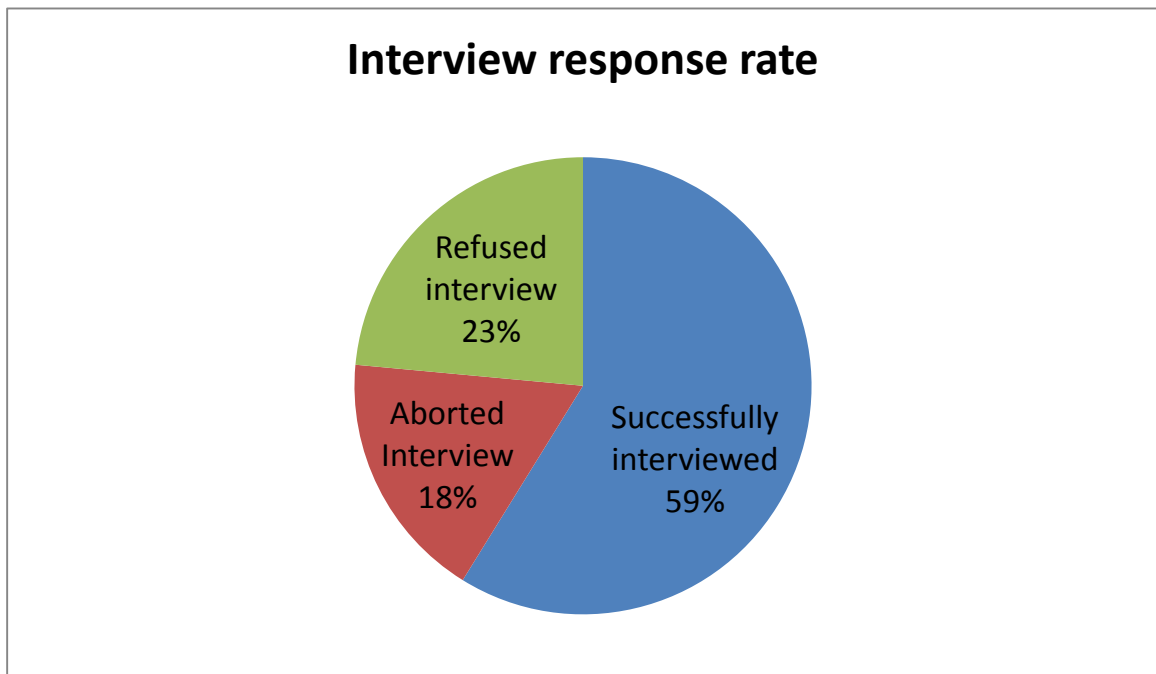


Figure 4.2 Interview response rate

4.5 Respondent Profile and Grade of the Company of the Respondent

Out of 10 respondent 2 of the respondent have an experience between 0 and 5 year; 6 of the respondent have an experience between 6 and 10 year; 1 of the respondent has an experience between 11 and 15 year; and 1 respondent has more than 15 year experience.

Nine of the respondents are project manager and one of the respondents is acting project manager.

Five of the respondent works in GC-1 contractors; three of the respondent works in BC-1 contractors; and two of the respondent works in GC-3 contractors.

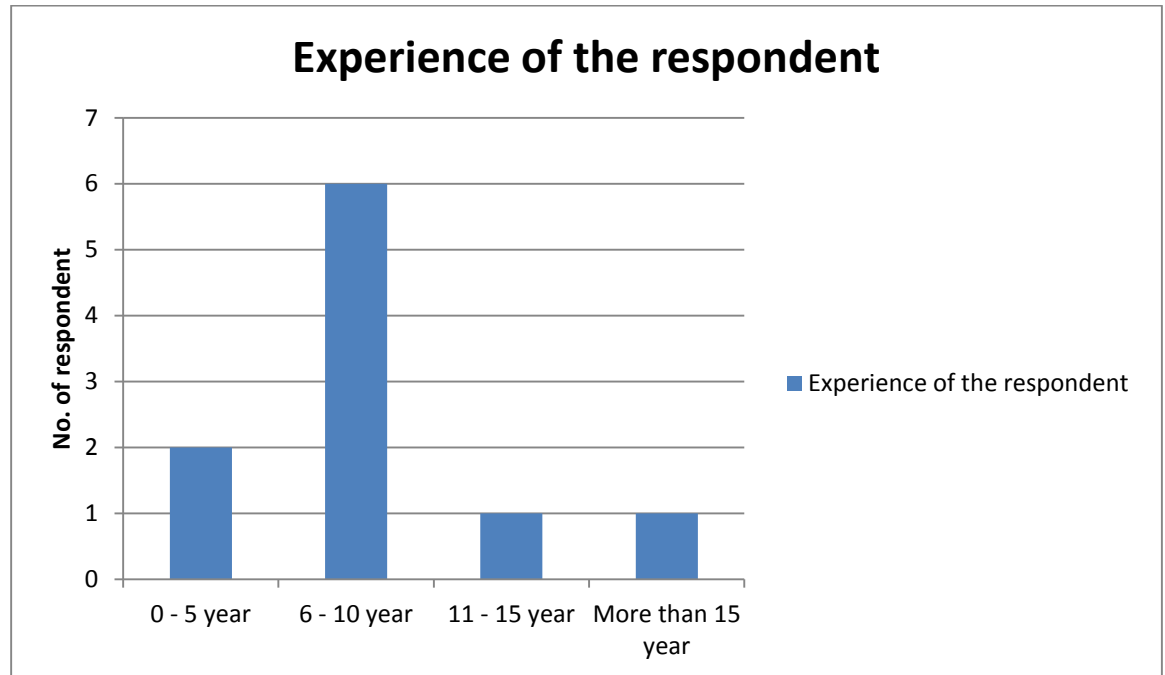


Figure 4.3 Experience of the respondent

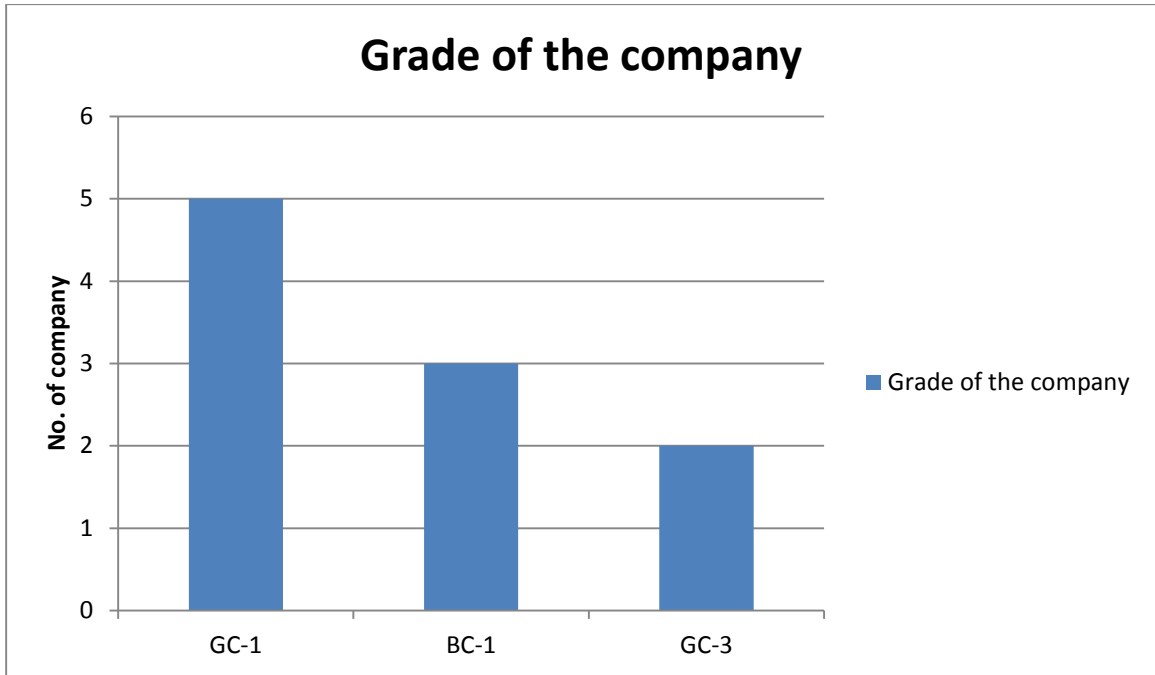


Figure 4.4 Grade of the company of the respondent

4.6 Extent of Material Management Problem

These questions address if poor construction material management is a problem in our construction industry. The result obtained indicates that most of the respondents considered poor construction material management as one of the major problems in building construction industry of Addis Ababa. Out of the total respondents 70 % of the respondents strongly agree and 30% slightly agree on poor construction material management as one of the major problem in the building construction industry of Addis Ababa.

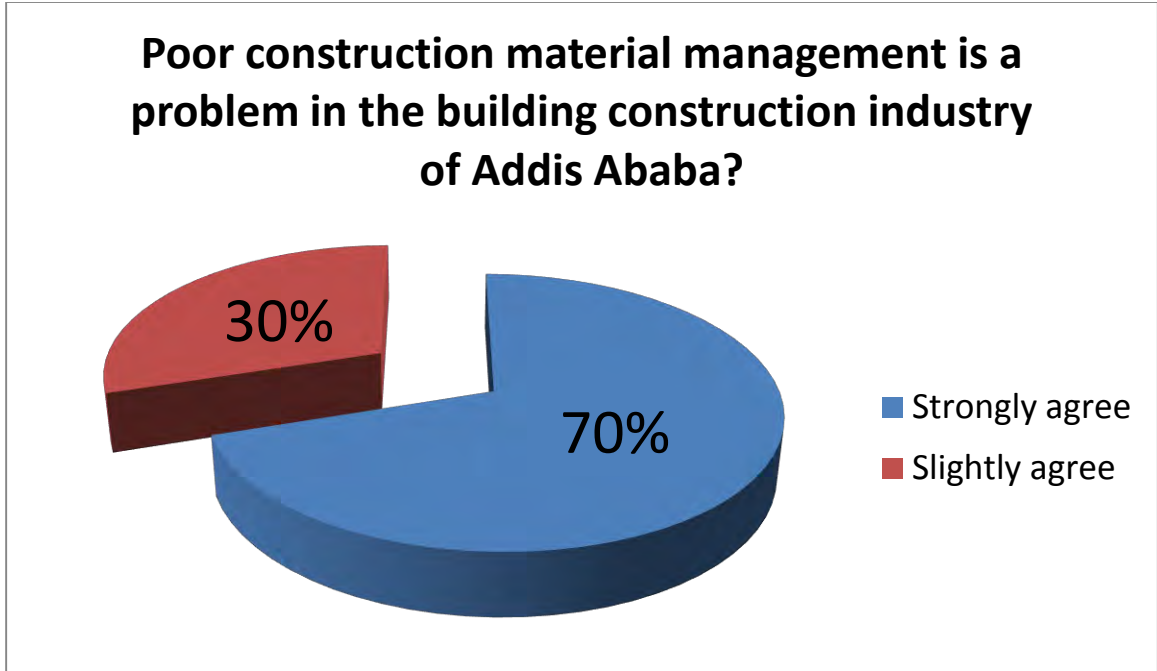


Figure 4.5 Poor construction material management problem extents

4.7 Performance Measures Usage

One of the objectives of this study is to determine performance measures used for material management on building projects in Addis Ababa. During the interview the respondents requested whether they use is in the past or currently the 26 performance measures described in the questionnaire. Based on the response of the respondents the percentage of usage of the performance measures shown on Table 4.2 as follows.

Table 4.2 Performance measure usage rating

No.	Measure Description	Number of responses	Current or past used response percentage (%)
1	Materials receipt problems	10	0
2	Warehouse inventory accuracy	10	40
3	Head office requisition percentage	10	0
4	Head office purchase order percentage	10	0
5	Sole source purchase	10	0
6	Minority suppliers	10	0
7	Procurement lead -time	10	60
8	Bid evaluate commit lead time	10	20
9	Purchase order to material receipt duration	10	0
10	Material receiving processing time	10	0
11	Commodity vendor timeliness	10	0
12	Commodity timeliness	10	0
13	Materials withdrawal request lead time	10	0
14	Materials withdrawal request processing time	10	0
15	Average man hour per purchase order	10	0
16	Freight cost percent	10	0
17	Construction time lost	10	0
18	Min/Max release activity	10	0
19	Warehouse safety incident rate	10	0
20	Total surplus	10	0
21	Material availability	10	0
22	Backorders	10	0
23	Material wastage	10	60
24	Purchase from foreign country	10	0
25	Discount from bulk purchase	10	0
26	Budget availability	10	0

The above performance measures were categorized into four different groups as follows:

- 1.High use: 76 -100%
- 2.Moderate use: 51-75%
- 3.Low use: 26-50%
- 4.Rare use: 0-25%

As shown on the table 4.2, none of the performance measures found under high use category. The performance measures identified as being moderately used are; Procurement lead –time and Material wastage. The performance measure under low use rate is warehouse inventory accuracy. The performance measures under rare use rate are; materials receipt problems, head office requisition percentage, head office purchase order percentage, sole source purchase, minority suppliers, bid evaluate commit lead time, purchase order to material receipt duration, material receiving processing time, commodity vendor timeliness, commodity timeliness, materials withdrawal request lead time, materials withdrawal request processing time, average man hour per purchase order, freight cost percent, construction time lost, Min/Max release activity, warehouse safety incident rate, total surplus, material availability, backorders, purchase from foreign country, discount from bulk purchase and budget availability. Around 88 percent of the performance measures found under rare use category.

4.8 Importance of the Performance Measures

The interviewed professionals gave their response about the importance of the performance measures by using 5 scales starting from 1 assigned to not important up to 5 assigned to extremely important as follows:

Not important : the assigned weight of 1

Somewhat important : the assigned weight of 2

Important : the assigned weight of 3

Very important : the assigned weight of 4

Extremely important : the assigned weight of 5

The collected data were analyzed using the Relative Index methods. Based on the frequency analysis the relative index was then calculated to determine the ranking of the importance of the performance measures.

The relative index analysis for variable is calculated by using the formula below:

$$RI = \frac{(5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1)}{5(n_5 + n_4 + n_3 + n_2 + n_1)} \dots\dots\dots [Eqn. 4.1]$$

Where:

RI = Relative Index

$n_5, n_4, n_3 \dots$ = Number of responding indices

The computation of the Relative Index using this formula will yield the value of RI ranging from 0.2 to 1.0. The values 0.2 represent the lowest strength and the value 1.0 representing the maximum strength.

Table 4.3 Importance of proposed performance measure

Rank	Measure Description	Number of responses	RI of importance	Importance (1-5)
1	Material availability	10	0.92	4.6
2	Material wastage	10	0.9	4.5
3	Construction time lost	10	0.86	4.3
4	Procurement lead -time	10	0.84	4.2
5	Materials receipt problems	10	0.80	4.0
6	Bid evaluate commit lead time	10	0.78	3.9
7	Budget availability	10	0.74	3.7
8	Total surplus	10	0.72	3.6
9	Discount from bulk purchase	10	0.7	3.5
10	Warehouse inventory accuracy	10	0.68	3.4
11	Purchase order to material receipt	10	0.68	3.4
12	Average man hour per purchase order	10	0.68	3.4
13	Purchase from foreign country	10	0.66	3.3
14	Min/Max release activity	10	0.64	3.2
15	Warehouse safety incident rate	10	0.62	3.1
16	Materials withdrawal request processing	10	0.6	3
17	Materials withdrawal request lead time	10	0.6	3
18	Material receiving processing time	10	0.58	2.9
19	Commodity vendor timeliness	10	0.56	2.8
20	Commodity timeliness	10	0.54	2.7
21	Head office requisition percentage	10	0.52	2.6
22	Head office purchase order percentage	10	0.48	2.4
23	Freight cost percent	10	0.46	2.3
24	Minority suppliers	10	0.4	2
25	Sole source purchase	10	0.36	1.8
26	Backorders	10	0.34	1.7

Based on the scored rate of each of the performance measures, they were categorized into four different groups as follows:

1. Extremely important : 4.25-5.0
2. Very important : 3.25-4.24
3. Moderately important : 2.25-3.24
4. Somewhat important : 1.25-2.24

The measures which gate a rate extremely important are: material availability, material wastage, and construction time lost.

The measures which gate a rate very important are : procurement lead –time , materials receipt problems, bid evaluate commit lead time, budget availability, total surplus, discount from bulk purchase, warehouse inventory accuracy, purchase order to material receipt duration, average man hour per purchase order, and purchase from foreign country.

The measures which gate a rate moderately important are: min/max release activity, warehouse safety incident rate, materials withdrawal request processing time, materials withdrawal request lead time, material receiving processing time, commodity vendor timeliness, commodity timeliness, head office requisition percentage, head office purchase order percentage, and freight cost percent.

Finally, the measures which gate a rate somewhat important are: minority suppliers, sole source purchase and backorders.

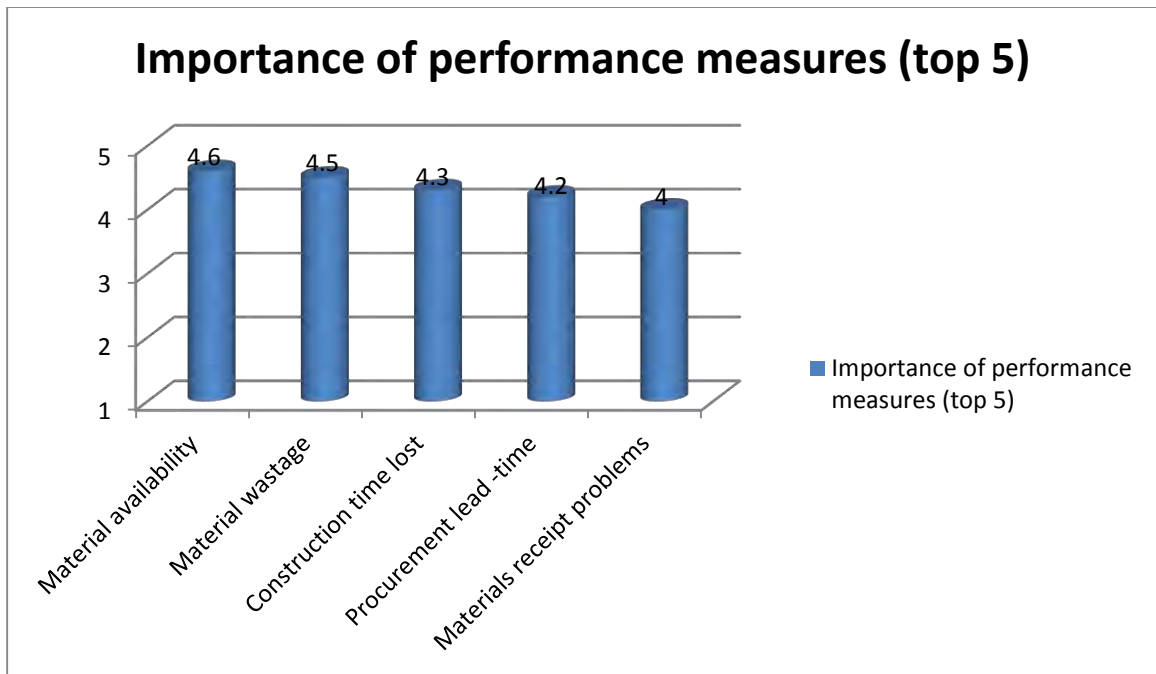


Figure 4.6 Top 5 important performance measures

4.9 Practicality of the Performance Measures

The interviewed professionals gave their response about the practicality of the performance measures by using 5 scales starting from 1 assigned to not practical up to 5 assigned to extremely practical as follows:

Not practical: the assigned weight of 1

Somewhat practical: the assigned weight of 2

Practical: the assigned weight of 3

Very practical: the assigned weight of 4

Extremely practical: the assigned weight of 5

The collected data were analyzed using the Relative Index methods in a similar way as calculated for the importance of performance measure.

Table 4.4 Practicality of proposed performance measure

Rank	Measure Description	Number of responses	RI of practicality	Practicality (1-5)
1	Total surplus	10	0.9	4.5
2	Materials receipt problems	10	0.88	4.4
3	Procurement lead -time	10	0.84	4.2
4	Sole source purchase	10	0.82	4.1
5	Material wastage	10	0.8	4
6	Bid evaluate commit lead time	10	0.78	3.9
7	Backorders	10	0.76	3.8
8	Purchase from foreign country	10	0.74	3.7
9	Warehouse safety incident rate	10	0.72	3.6
10	Freight cost percent	10	0.7	3.5
11	Material availability	10	0.68	3.4
12	Discount from bulk purchase	10	0.66	3.3
13	Min/Max release activity	10	0.64	3.2
14	Budget availability	10	0.62	3.1
15	Warehouse inventory accuracy	10	0.6	3
16	Head office purchase order percentage	10	0.56	2.8
17	Head office requisition percentage	10	0.54	2.7
18	Minority suppliers	10	0.5	2.5
19	Purchase order to material receipt	10	0.48	2.4
20	Materials withdrawal request lead time	10	0.46	2.3
21	Material receiving processing time	10	0.42	2.1
22	Materials withdrawal request processing	10	0.42	2.1
23	Construction time lost	10	0.4	2
24	Commodity timeliness	10	0.38	1.9
25	Commodity vendor timeliness	10	0.28	1.4
26	Average man hour per purchase order	10	0.28	1.4

Based on the scored rate of each of the performance measures, they were categorized into four different groups as follows:

1. Extremely practical : 4.25-5.0
2. Very practical : 3.25-4.24
3. Moderately practical : 2.25-3.24
4. Somewhat practical : 1.25-2.24

The measures which gate a rate extremely practical are: total surplus and materials receipt problems.

The measures which gate a rate very practical are : procurement lead –time, sole source purchase, material wastage, bid evaluate commit lead time, backorders, purchase from foreign country, warehouse safety incident rate, freight cost percent, material availability, and discount from bulk purchase.

The measures which gate a rate moderately practical are: min/max release activity, budget availability, warehouse inventory accuracy, head office purchase order percentage, head office requisition percentage, minority suppliers, purchase order to material receipt duration, and materials withdrawal request lead time.

Finally, the measures which gate a rate somewhat practical are: material receiving processing time, materials withdrawal request processing time, construction time lost, commodity timeliness, commodity vendor timeliness and average man hour per purchase order.

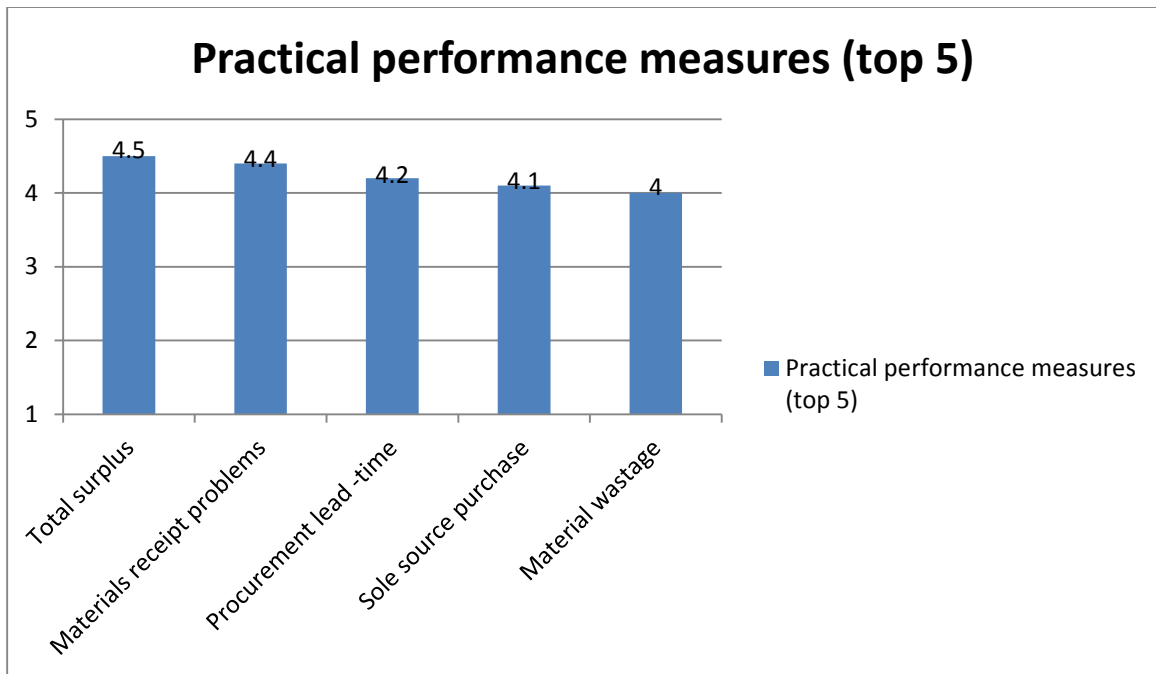


Figure 4.7 Top 5 practical performance measures

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the result from the analysis of this research, the following can be concluded:

1. Construction material management performance measures used rarely in Addis Ababa building projects.
2. Construction material management performance measures are very important to measure the effectiveness of the material management process in Addis Ababa building projects.
3. Most of the construction material management performance measures identified in this study are practicable in Addis Ababa building projects.
4. Most of the professionals who work on material management related area in Addis Ababa building projects have lack of knowledge about construction material management performance measures.
5. The finding of this study helps to develop benchmark for effective construction material management process for building projects in Addis Ababa.

5.2 General Recommendation

- The construction industries should use performance measures.

- Construction companies should develop benchmarks by using performance measure for evaluation.
- Construction companies should train their professionals about construction material management performance measure and its benefit.

5.3 Recommendation for Further Study

- Study can be done to develop the computerized construction material management system.
- Similar kind of study can be conducted on road projects and water work projects.
- Study can be done to identify the obstacle for the usage of performance measures.
- Study can be done to measure the effectiveness of the projects by using the identified performance measures.

REFERENCE

- [1] Bell L.C. and Stokhart G.(1986), Attributes of material management systems, Journals of construction Engineering and Management, ASCE,112(1), pp14 -21
- [2] Bell L.C, and Stokhart G.(1987), Cost and Benefit of material management systems, Journals of construction Engineering and Management, ASCE,113(2), pp 222 -234
- [3] Business Dictionary, Retrieved on July 05,2015, <http://www.businessdictionary.com/definition/materials-management.html#ixzz3k1qjAdnW>.
- [4] Know the Power of Material Management in Construction Management Company, Sep 8 2014, Retrieved on July 05,2015, <http://www.cembs.com/blog/post/material-management-in-construction-management-company>.
- [5] Material Management Dictionary, Retrieved on July 05,2015, http://www.12manage.com/description_materials_management.html
- [6] Plemmons, J. K., Materials management process measures and benchmarking in the industrial construction industry. Ph.D Dissertation, Clemson University, Clemson, 1995.
- [7] The Federal Democratic Republic of Ethiopia Cooperative Agency Materials Management Training Material for Cooperative Promoters, Cooperative Promotion and Regulation Core Process Coordination, March 2009, Addis Ababa
- [8] Tutu Wegelius-Lehtonen , March 2000 ,Performance measurement in construction logistics, International journal of production economics, *02015 HUT*.
- [9] Ye construction Kefle Economy yeasser Amet Lemat Meri Eked, Part 2,1982, Addis Ababa

APPENDIX:
QUESTIONNAIRE

SURVEY ON:

- ✓ Assessment of Performance Measures for Material Management Process on Building Projects in Addis Ababa

I kindly request you to involve your company by providing relevant information for my project.

The information that you will provide will kept confidential and it is intended only to serve for academic purpose.

Finally, I would like to thank you and appreciate your willingness and cooperation.

SECTION – 1 Company and respondent profile

Please provide the following information about your professional and organizational profile by marking (X) in the space and also filling the blank spaces provided as appropriate.

1.1 Respondent Information:

Name (Optional)	
Company Name (Optional)	
Status (Title)	
E-mail Address	

1.2

Your professional experience in – Construction Sector related to material management?	
0-5 years	
6-10 years	
11-15 years	
More than 16	

1.3 Grade of your company given by the Ministry of Works and Urban (GC,BC, etc level)?

SECTION – 2 Basic information about construction material management problem

2.1 Poor construction material management is a problem in Addis Ababa building construction industry?

Strongly agree Slightly Agree Strongly disagree slightly disagree Neutral

SECTION -3 Questionnaires of performance measures

No.	Measure Description	Used Past/Curren t (yes/no)	Importance *	Practicality **
1	Materials receipt problems			
2	Warehouse inventory accuracy			
3	Head office requisition percentage			
4	Head office purchase order percentage			
5	Sole source purchase			
6	Minority suppliers			
7	Procurement lead -time			
8	Bid evaluate commit lead time			
9	Purchase order to material receipt duration			
10	Material receiving processing time			
11	Commodity vendor timeliness			
12	Commodity timeliness			
13	Materials withdrawal request lead time			
14	Materials withdrawal request processing time			
15	Average man hour per purchase order			
16	Freight cost percent			
17	Construction time lost			
18	Min/Max release activity			
19	Warehouse safety incident rate			
20	Total surplus			
21	Material availability			
22	Backorders			
23	Material wastage			
24	Purchase from foreign country			
25	Discount from bulk purchase			
26	Budget availability			

**Extremely important -5; Very important -4; Important -3; Somewhat important-2; Not important -1*

***Extremely practical -5; Very practical -4; Practical -3; Somewhat practical -2; Not practical -1*