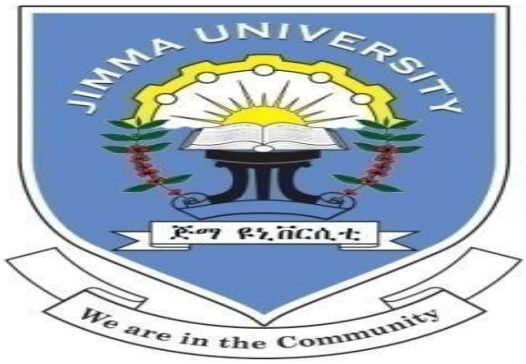

JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF GRADUATE STUDIES

FACULTYOF CIVILAND ENVIRONMENTAL ENGINEERING

CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

INVESTIGATION OF DEFECTS DURING DEFECT LIABILITY PERIOD AND RETENTION PAYMENT IN PUBLIC BUILDING CONSTRUCTION PROJECT IN JIMMA TOWN

A Research Thesis Submitted to School of Graduate Studies, Jimma University, Jimma Institute of Technology, and Faculty of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Construction Engineering and Management

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BY

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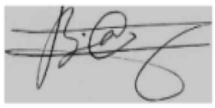
3. Dr. Eng. Bayou Chane Tegegne		04/ Sept/2020	
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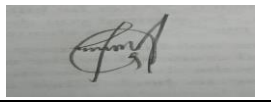
5. Eng. Moges Getahun		04/ Sept/2020	
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DECLARTION

I declare that this research entitled ‘‘**Investigation of defects during Defect Liability Period and Retention Payment in Pubic Building Construction projects in Jimma Town’’** is my own original work, and has not been submitted as a requirement for the award of any degree in Jimma university or elsewhere.

Name: Endue Gebregziabher

Signature _____ Date _____

As research adviser, I hereby certify that I have read and evaluated this paper prepared under my guidance, Enque Gebregziabher entitled ‘‘**Investigation of defects during Defect Liability Period and Retention Payment in Public Building Construction projects in Jimma Town’’** and recommend and would be accepted as a fulfilling requirement for the degree master of science in construction engineering management.

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ABSTRACT

After practical completion of the whole works, the contractor requests the Engineer for the provisional acceptance, and during provisional acceptance the engineer to notice the unfinished works or not commissioned according to contract document. Then the contractor is obliged to rectify the defects that occurred before and after the practical completion during 12 months of defect liability period that occurred due to poor workmanship, quality material deficiency and carelessness of the contractor.

This study aimed at the investigation of defects during defect liability period and retention payment in public building construction projects in Jimma town. It identified and analyzed the type and cause of defects that occurred during defect liability period and evaluated the adequate amount of retention payment to rectify defects during Defect Liability Period, its impact on the projects on time close-out on public building construction of in Jimma town. After pertinent literatures were reviewed both primary and secondary data collected through questionnaire, interview and disk study. The sample was selected from Jimma Town by purposively sampling targeting in public building constructions. 58 structured questionnaires were distributed to personnel in the offices of contractors, consultants, and clients to obtain the desired data for analysis. 52 questionnaires representing a response rate of 89.65% were returned and analyzed using descriptive and inferential statistics with the assist of statistical package for social sciences (SPSS).

The results are analyzed according to the study; the types of defects are Leakage of roof, Damp/leakages in ceilings, peeling off paint, Short circuit in Breaker and Seepage from defective pipe works or sanitary fixture. The causes of defects in public buildings are Poor Workmanship, poor project management, Defective construction material, Faulty Design, and Poor supervision of site workers. The amount of 5% retention payment (2.5% during defect liability period) enough to rectify defects the whole problem that happens on the building construction then agree by 48.08% of the respondents.

It can be concluded that improper construction management, uneven measurement, the use of low-quality materials standards, and poor workmanship end with more defective results. Hence, the study recommended that proper construction management is required so that careful measurement, quality materials, and efficient and skilled workers could be implemented during the construction stages of the project and during the Defect Liability Period. Moreover, strict supervision of public building projects must be provided especially the material quality standard ensured by approval and strict follow-up there must be each individual works during construction stage.

Keywords: - *Defects, Defect Liability Period, Retention Payment*

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ABBREVIATION

MoWUD	Ministry of Works and Urban Development
PPA	Public Procurement Agency
DLP	Defect liability period
FIDIC	Federation International des Ingenious – Conseils, a French acronym with Its English equivalent of "International Federation of Consulting Engineers"
BOQ	Bill of Quantities
DBB	Design-Bid-Build
ETB	Ethiopian Birr
SBD	Standard Bidding Document
CT	Contractor
CSA	Central Statistical Agency
SCC	Special conditions of contract
GCC	General Conditions of contract
RII	Relative important index
SPSS	Statistical Package for Social Sciences

CHAPTER-ONE

1. INTRODUCTION

1.1. Background

Defects liability period is the period stated in the Special Conditions of Contract immediately following the date of provisional acceptance, during which the Contractor is required to complete the works and to remedy defects or faults as instructed by the Engineer; (PPA, August 2011).

Defect liability period is a period stated in the construction contract document agreement. During this period, the occurrence of defects is at the contractor's own liability and the contractor shall be called upon to return to the site to rectify the defects as necessary. In order to attain conformity with the contract, the usual measure of damages for defective work is the cost of rectifying the defects (Holmes, 2010).

Building works which fell short of complying with the requirements of contract, specifications or contract drawings, together with conditions of its quality and any implied terms, durability, workmanship, design or performance, aesthetic can be defined as defective building works (Y. J. Cho, 2006, cited in Alan, 1990). Described defects in building works are premature failure resulting from errors of workmanship, design, the use of faulty materials or inadequate maintenance.

In general terms defects or defective works are where the standard and quality of workmanship and materials as specified in the contract are deficient. Defects can be classified into two main categories, Patent Defects, and Latent Defects. Patent defects are defects that can be discovered by normal examination or testing whereas Latent Defects are defects that are not discoverable by normal examination or testing which manifests itself after a period of time (Anon, 2007).

According to Dalib, (2010) defects in buildings give a negative impact on the value of a construction project and a bad perspective towards the responsible development of the projects. In terms of building construction generally, there are several parties involved in the decision making of the designer or consultant, contractor or builder and owner. One or all of them might become the source or causes of defects or damage to the building. Among the source of failure of the building are irregular direction from the project management, lack of information, frequent changing of results, inefficient monitoring and perfunctory also affects damage and defects in the building

Defines defect in the context of a building contract as a failure of the completed project to fulfill the quantity obligation, implied a quality or express quality of the construction contract. Defects in

building occur during construction, during defects liability period and post defects liability period. Most of the defects verified in the recent years occurred during construction stage (Arends, 2015)

Construction defects are very common and often arising or spot in the construction project, especially in the project which has poor management or supervision in the construction site. A construction defects can be known as a major problem in the construction industry that could cause the value of a building to decrease eventually (UKEssays, 2018). In addition (Entrusty, 2007) stated Defects or defective works is where the standard and quality of workmanship and materials as specified in the contract are deficient.

Defective work in construction and engineering projects is a common issue that usually arises at completion of the works. Although construction contracts contain details dealing with treatments of defective work during the course of construction, prior to completion and during the defects liability period or the rectification period, the defect issues are still being a common dispute between the employer and contractor, especially in situations where the contractor fails to rectify the defects during a period of time agreed or within Defect Liability Period (DLP) (Roslan, 2017).

According to Anne-Marie, (2011) the purpose of Defects liability periods - also known as rectification provisions - can be of benefit to both parties. For the contractor, it is likely to be more economical and efficient for it to carry out remedial works itself than to pay the costs of another contractor hired by the employer. From the employer's perspective, it will not need to hire an alternative contractor to carry out the work, or to carry out the work itself and reclaim the cost. The employer will also not run the risk that any warranties provided by the original contractor may be affected by a third party carrying out works on the site.

If there is a contractual right for the contractor to rectify defects, and the employer either does not notify the contractor that rectification is needed or refuses access to the site, then the employer may be in breach of contract. Case law illustrates, however, that the contractor will not normally be 'let off the hook' if this happens. The employer will still have a claim for the cost of rectifying the defects, but the claim is likely to be limited to the amount it would have cost the original contractor to carry out the works. It will not be able to claim for remedial works or working methods found not to be strictly necessary.

Employers should therefore give careful consideration to the provisions in the contract before hiring a new contractor to carry out remedial works. This is especially important if the contract stipulates that the employer must notify the original contractor that remedial works are needed before it can make a claim for recovery of any costs of rectification.

Similarly, in Entrusty, (2007) under a contract, the contractor has to ensure the completed works upon handing over to the employer are free from defects. The employer bears the right to call back the contractor to site for any defects discovered within the DLP and to give instructions or notices to the contractor to rectify the defective works. The contractor is responsible to rectify the listed defects within the allowed period. However, it was noted that failing to issue the required notice shall not preclude the employer to employ another contractor to rectify the defects and recover the remedial cost.

According to (Minter, www. constructionalawmadeeasy.com) Rectification after completion of works, The contractor's failure to perform work in accordance with the construction contract is a breach of contract and entitles the principal to sue the contractor for damages at common law. However, most construction contracts include contractual mechanisms which; allow the contractor to the site to rectify defects, nominate a defect liability period (DLP) which is a period after practical completion during which the principal or its representative may, by notice, require the contractor to rectify defects, entitle the principal to have a time party rectify the defect if the contractor does not follow the rectification notice and allow the principal access to security or retention to pay for the rectification.

According to PPA/Public Procurement Agency/ (2006) clause 48.2 on completion of the whole of the Works, half the total amount retained shall be repaid to the Contractor and half when the Defects Liability Period has passed and the Engineer has certified that all Defects notified by the Engineer to the Contractor before the end of this period have been corrected. And PPA, (August 2011) clause 61 sub clause 61.1 The sum which shall be retained from interim payments by way of guarantee to meet the Contractor's obligations during the Defects Liability Period, and the detailed rules governing that guarantee, shall be stipulated in the SCC, provided that it shall, in no case, exceed 10% of the contract price.

Retention is contractual practices originally introduced provide security against defective work or the insolvency of construction firms. It on completion of the whole of the Works, half the total amount retained shall be repaid to the Contractor and half when the Defects Liability Period has passed and the Engineer has certified that all Defects notified by the Engineer to the Contractor before the end of this period have been corrected. It is customary that the first half is released at project completion and that the other half is released following the expiry of a defects liability period (typically 12 to 24 months) for the project.

In theory, retention encourages efficiency and productivity for the construction project. It helps ensure that contractors achieve practical completion on a timely basis so their initial retention payment is released. The use of retentions also acts as an incentive for a defect-free project at the end

of the defects liability period (Constructionpayment.consultation@beis.gov.uk, 2017). The purpose of this research was to investigate the common construction defects, during defect liability period in the construction projects in Jimma Town.

1.2. Statements of the problem

The Jimma Town has many public building constructions constructed in contract agreements conducted between local and foreign contractors with owners in the previous years. Hence, the owners of the buildings through contractors carefully monitor and follow up the consultants to construct quality buildings; the contractors also want to accomplish their tasks with quality in the agreed time. However, such fast agreements are not easily facilitated in the practical situation as there are always expected 'defects (Georgiou, 2010). Thus, the contractors are expected to rectify defects on the completed buildings before issuing the final retention payment, at the given defect liability period of the 12 months.

Most of the time, at the practical completion of the works, during defect liability period the owners have many complaints about construction defects on these public building constructions, because, the buildings cannot function properly. The contractors try to rectify the defects of their works so that they can influence the owner to release the final retention payment. However, such agreements of defect rectifications have not been easily accomplished in the actual real situations and this makes it difficult for the contractors to handover the buildings to the owner. These defects will be an additional burden to the employer for the follow-up of the correction of the works and maintenance required unless contractors discharge their obligations under the contract without proceeding with legal procedures and repeated correspondences. Such inevitable defect issues in construction works have always been contentious between the employer and contractor. Consequently, Jimma Town building construction projects are not timely closed-out.

Hence, unresolved defective issues may cause some negative impacts on both parties, in terms of expenditure; time, and reputation in the industry (Georgiou, 2010). Thus, most of the claims made by employers in Jimma Town are related to defects, and they often lead them to economic loss after many years the work was carried out. Therefore, the research at hand was intended to be evidence for defect-related reasons that consign disagreement among the contractors and the building owners by investigating the type, causes of defects occurred during the defect liability period, and to evaluate the amount of defect rectifying retention payments. To this end, the study answers the following research questions.

1.3. Research Questions

The research questions are as follows:

1. What are the types of defects that occurred during the defect liability period on a public building construction projects in Jimma Town?
2. What are the causes of the defects that occurred during the defect liability period on public building construction project in Jimma Town?
3. Is the percentage (5% x 1/2) allocated for retention payment adequate to rectify the actual defects during the defect liability period on public building construction project in Jimma town?

1.4. Objectives

1.4.1. General Objective

This study was mainly intended to investigate reasons for contentious endings between public building contractors and owners in relation to defects with the retention payments that delayed the close-out of the projects, during the defect liability period in Jimma Town building construction projects.

1.4.2. Specific Objectives

This study was specifically intended:

1. To identify the types of defects that occurred during the defect liability period on public building construction in Jimma town.
2. To assess the causes of defects that occurred during the defect liability period on public building construction in Jimma town.
3. To evaluate the required amount retention payment to rectify defects during defect liability period on public building construction in Jimma town.

1.5. Significance of the Study

The main purpose of this research is to help the stakeholders of the construction industry, that is, the client, consultant, contractor and government; to assist the employer to have a better perspective in addressing construction defective issues by choosing the best approach to settle it soon enough in pubic building constructions of Jimma town. The type and main causes of building defects during Defect Liability period the factors leads to poor workmanship, poor quality materials and design deficiency. Knowing the reasons behind it will help to provide the necessary rectify defects in order to reduce similar future problems and keep the users safe and satisfied. The thesis output will

reference other studies in the area of the construction industry and it will also be utilized as initial information for further detail research works. It is an initiative for other researchers on the related issue and related problems by contributing some findings that can possibly serve as spring board.

1.6. Scope of the study

The scope of the research is to identify the construction defective works during DLP according to the construction contract of rectified defects that appear in the works. This study is conducted by assessing the causes, impacts, and rectification of the defective works on pubic building constructs of on Jimma town. And the focus of this study is limited to:

a. Defective works within the Defect Liability Period only.
b. Liability of defective works between employer, consultant and the main contractor only.

1.7. Limitation of the Study

It is not possible for any research process without limitations or challenges; the situation is similar to this research too. The process was not easily accomplished. There are different challenges the researcher countenanced while doing this research, especially at the data collection period. Among them the major limitations are Problem of willingness of some respondents, Financial and other social problems, and Resistance of the office workers to give secondary data.

So the aforementioned challenges limited the researcher to address more issues and study areas, and finally accomplish on time.

CHAPTER-TWO

2. LITRATURE REVIEW

2.1. Introduction

Construction contracts usually include a defects liability period during which the contractor is responsible for repairing or rectifying defects that appear in the works. The period usually commences upon practical completion of the works and runs for a specified time frame (sometimes also known as the maintenance period) (Damian, 2016). During the defects liability period, typically: the contractor has the right to return to the site to rectify defects or complete unfinished work; the principal is entitled to continue holding security, to secure the contractor's obligations in respect of incomplete or defective work; and The superintendent continues to remain involved in the project(bca_itsupport@bca.gov.sg, 2018). The contractor is expected to carry out the construction work in workmanlike manner so as to meet the requirement and specification for the project. The condition of the contract may be such that the period of making good defects in construction can be divided into three during construction, during defects liability period and post defects liability period (Ojo, 2010).

During the construction, it is generally believed that the contractor is entitled or has a contractual right to remedy any patent defect or latent defect becoming patent, at any time up to the date of handing over of the works to the employer. He is expected to be informed of any defective works by the employer's representative of the defects and make good at contractor's cost. Should he fail to rectify such defects either on his own or upon instruction of the contract administrator, he is culpable of breach of contract.

During the defects liability period, which commences on the completion of the works, standard forms of contract generally give the contractor a license to return to the site for the purpose of remedying defects. In effect, such a condition of contract confers upon the contractor a right to repair or make good its defective works, which can (usually) be carried out more cheaply and (possibly) more efficiently than by some outside contractor bought in by the employer. Reference (Harbans, 2003). Defects after defect liability period can still be treated by contractor depending on the standard form of contract. It is the contractor's obligation under the contract to rectify the defects that appears during DLP.

2.2. Definition of Defects

The term defect is defined by different scholars differently. For instance, (Alan, 1990) defines 'defects' in building works are premature failure resulting from errors of workmanship, design, the use of faulty materials and inadequate maintenance. According to the Webster's Dictionary, a defect is defined as a lack of something necessary for completeness (Ahzahar, 2011). In the view of Cho et al. (2006), building works which fall short of complying with the requirements of contract, specifications or contract drawings, together with conditions of its quality and any implied terms, durability, workmanship, design or performance, aesthetics, etc. can be defined as defective building works. A building defect may include any problem that reduces the value of a home, condominium, or building (Ahzahar, 2011). And Allotey, (2014) Defined a building defect as any characteristic exhibited which hinders the usability of the building for the purpose which it was designed and constructed. In general, a defect is a fault in the workmanship in the construction of a new build property, or a fault in the installation or manufacture of items of equipment which form part of the construction.

2.3. Defects in Construction

Defects, which may be latent or patent, can arise on construction projects due to design, materials or workmanship which fail to comply with the requirements of the contract. Patent defects are those which, on reasonable inspection, are plain, evident or conspicuous and can normally be seen with the naked eye (Roger, Third Edition 2012).

Defective construction works can be defined as works that fall short of complying with the express descriptions or requirements of the contract. The majority of modern buildings and civil structures are complex and involve the use of a great variety of engineering methods and processes. Defective construction contributes to both the final cost of a project and the cost of maintenance, which can be substantial. Therefore; most projects face the possibility of defects and defective work, which generally result in structures that cannot perform their originally intended roles (Ojo, 2010).

According to Georgiou, (2010), Defective construction includes activities such as compaction not done to specifications, which leads to ground movement and eventual failure of foundations. This may lead to the complete failure of a structure. He classified defects into two main categories, namely patent defects and latent defects.

2.3.1. *Patent Defects*

When a contractor has completed the work included in the contract, most standard forms of the contract provide for the employer's representative to issue a document to signify that the work has been completed in accordance with the requirements of the contract (Roger, Third Edition 2012).

Broadly, a defect is anything that renders the works (or a thing) unfit for the use it was intended for when used in a reasonable way and with reasonable care. In the context of a construction contract, work may be defective if it is not carried out in accordance with the contract (Yassir, 2014).

According to Sanderson va patent defect is not latent when there is none to observe it. The natural meaning of the word 'patent' is objective, not subjective. It means' observable, not observed'. A patent defect must be apparent on inspection, but it is not dependent on the eye of the observer; it can blush unseen. In this case, although the defect was in darkness, it was patent. Had the plaintiff or his mate shone their lamps on it at the relevant moment, they would have seen it (National Coal Board, 1961: 244).

2.3.2. *Latent Defects*

According to Roger, Third Edition (2012) stated Defects that come to light after the patent defects have been made good and the appropriate documentation issued are normally referred to as latent defects. The contractor is not excused in any way for latent merely because of the issue of documentation which signifies that the employer or his representative is satisfied at the time the documentation was issued.

According to Yassir, (2014) a latent defect is by its own nature concealed. It may not manifest itself for many years. A typical example might be defective foundations that do not become apparent until cracks appear in the building many years later.

However, if the employer identifies a defect just after the defects liability period ends, arguably the damages it may recover should not be affected by the decision in Pearce v Baxter. This means that, in practice, it may be in the contractor's interests to argue that an architect or engineer should have spotted that defect during the defects liability period so that it can try to gain a tactical advantage by offering to remedy the defect itself or pay the cost of curing the defect alone.

2.4. Types of Building Defects

In Abdul Rahman H., (1996) defines defects in construction include either or a combination of the following; defects in structure, giving rise to cracks or collapse; defects or faults in electrical and plumbing installations; inadequacy of drains for proper disposal; insufficient provision for

ventilation; poor cooling and/or heating system; poor sound insulation system, and insufficient fire prevention or protection mechanism.

According to N.H. Che Hasim, (2015) stated the types of defects which commonly occurred during defect liability period were identified, as cracks on the wall were the most common defect that can be found on during DLP. In addition, Bedru, (2015) stated the first five most frequent types of defect in federal building construction were broken or loose tiles on floors or wall; water seepage from external wall, roof, or from ceiling; broken or leaking sanitary fixtures; defective damp proofing at the roof; poor window framing and nonstructural crack respectively.

2.4.1. *Peeling of Painting*

As stated by (Ghafar, 2004) in refer (Yebichaye, 2016) Peeling paint usually occurs on building facades, mainly on plastered walls, columns and other areas that are exposed to excessive rain and dampness. Some buildings that are located near the sea may face a much higher risk once the signs of peeling paint are visible on the exterior walls. The majority of peeling paint problems occurs on surfaces exposed to the rain, sun, and the varying degree of temperature. Walls that have involved can be an unsightly mess in a home or building. It may result in embarrassment and frustration to the homeowner. The amount of the constant wind, rain and sun received can easily turn the surfaces of the paint to become chalky and wrinkled or blistered. This problem can become worse if the paint used during construction is low quality and mixed with excessive amount of water.

2.4.2. *Roof covering defect*

Roof defects are divided into structural faults and defects in waterproofing material. The majority of roof defects that occurs are distortion of either the roof or off the wall at roof level. Normally, structural defects can be identified from the visual inspection. For the defect of waterproofing material, it will provide the building to be durable under a wide range of exposure condition.

Construction defects in roof system can cause damage to personal property in a home or building, and also to the interior framing members, ceiling, drywall, and paint by allowing water into the building. Common roof system construction defects break roof tiles, damaged framing, exposed damage felt, improper flashing, raised shadow board and loose tiles. A faulty installation is grammatically increasing the likelihood of problems and reduces a roof system’s life expectancy (David, 1988).

Bedru, (2015) mentioned that there are many different types of roofing defects, most are known to be caused by:

Improper installation

The installation of roof will need a number of skilled workers. If the roof is improperly installed, it wills yield to roof defect such as roof leakage and sagging. The causes of roof defect are because the worker maybe not have a license, or certificate apart from having a low level of experience.

Poor workmanships

Quality of workmanship is needed such as to maintain and construct the roof. The life expectancy will be reduced due to the poor workmanships which are can both bring to loss for both the dealer and the buyer.

Defective materials

Materials themselves also may be the factors to the roof defect. The material too, may be not suitable to weather condition. Sometimes, it is not installed correctly also due to sagging and deformation.

2.4.3. *Cracking*

Cracks can be structural or nonstructural. A structural crack means any defect in a structural element of a building that commonly occur in areas such as interior walls, exterior walls, beams and columns. Such type of crack may be caused by many factors, e.g. excessive movement of the building structure, unwanted ground settlement, serious overloading, and weaknesses caused by corrosion/deterioration of materials, damage from accidents, or poor design/ construction, etc. Detailed investigation must be carried out to identify the causes which must be removed or rectified before the cracks are repaired. The other one is non -structural cracks. Such type of cracks usually occur in plaster or other finishes with cement, sand rendering as base due to shrinkage cracks in plaster or other forms of finishes. It will affect the appearance only and do not pose any safety concern. They are small hairline cracks developed within the finish layer not penetrating down to the reinforced concrete structure (Kasim, 2009).

2.4.4. *Dampness*

Dampness in buildings can arise from a number of sources and it is important to trace the cause of the problem before deciding what repairs are required.

According to (Elhag T & Boussabaine, 1999) most common causes of dampness are likely to be:-

- **Penetrating dampness** – Moisture entering the building from the outside due to a defect in the structure, such as a leaking roof, flashing or rainwater pipe.
- **Rising Dampness** – Moisture from the ground rising up the external walls due to the damp-proof course being absent or defective.
- **Leaks on Services** – Leaks from tanks, pipes, sanitary fittings or drains that are causing dampness to the fabric of the building

Dampness can arise from unintended water caused by leaking pipes, gutters and flashings. The leaking water penetrated into the wall, resulting in horrible water stains. Under long term of dampness penetration and poor ventilation within the building, excessive moisture promoted the growth of mound on the surface of wall (Zulkarnain H.S, 2011).

Dampness also occurs when water penetrates through capillaries or cracks between mortar joints and bricks or blocks before building up trap moisture behind hard renders. Moreover, the contribution of dampness is due to the existence of gravity. The other factor such as leaking gutters or down pipes, defective drains, burst plumbing, and condensation due to inadequate ventilation also can be the factors yielding (Rojer, 2005).

Dampness can be a genuine matter, especially to structures situated close water sources. Does it break down building structures as well as harms to decorations? The primary driver of clamminess is water entering a working through various courses. Water infiltration happens usually through dividers presented to winning wet wind or rain. With the presence of gravity, water may infiltrate through vessels or splits between mortar joints, and blocks or squares before working up trap dampness behind hard renders. Water may likewise drive additionally up the divider to rise at a more elevated amount. Clamminess additionally happens in dividers because of different components, for example, spilling canals or down funnels, faulty channels, burst pipes and buildup because of lacking ventilation (Okuntade, 2017).

2.4.5. *Leakage Pipes*

According to (Rojer, 2005) in refer (Yebichaye, 2016) that Leaking is water that seeps out from behind walls, under concrete slabs and asphalts, basements, landscaping, water intrusion in roofs, irrigation systems, and radiant heat system. Leaking mostly happened due to improper installation of piping system that can cause dampness and mold growth, water penetration through external wall defects such as cracks, joints, honeycombs, spelling, weak points, holes, punctures, leftovers of debris, and movement of external wall components, water penetration through defective external wall finishes such as loosened mosaic tiles, cracked ceramic tiles and paint surface; through poor cladding or curtain walls constructions; or weaknesses in water-resisting components, Water leakage through party walls between units of pre-fabricated elements, or between buildings.

2.4.6. *Floors and Floor Finishes*

Floors exhibit a range of defects related to their expected performance in use. The main functions of flooring are structural adequacy, including the transfer of all loads (dead and imposed) to the ground or the walls/ foundations without deflecting excessively; to resist water penetration; to control thermal losses; and to provide a safe and stable surface. Special requirements include fire resistance

and control of acoustic transmission. Floors can be deficient in any or all of these contexts. Floors may be structurally inadequate because of failures in their bearing at their end supports (or in the case of large spans, possibly at the mid-support also). They may also be defective through excessive span for their sizing, or overloading beyond design specification. Excessive notching, especially in the sensitive middle third of the span, can produce bending as a result of overloading (Hinks, 2003).

2.4.7. *Defects in Doors, Windows and External Appendages*

Aluminum doors and windows have been widely used in new developments and as replacement of steel windows in existing buildings, but recent incidents of their failure have aroused safety concerns. The aluminum window system involves the assembly of a certain number of components by rivets, screws, hinges and fixing anchors. These accessories, which are prone to failure, require regular servicing and maintenance to prevent failure (Ghafar, 2004).

The friction slide hinges are delicate parts of the window which demand close attention to avoid accumulation of dirt that obstruct the sliding motion and mild lubrication to reduce friction of the moving parts. Without the required servicing and maintenance, hinges may become too tight to operate, rivets may loosen up and screws may be corroded that shorten their lifespan. When excessive forces are applied to operate such windows or when they are subject to wind load, distortion of the window sashes or even the frame may result, causing fatal or serious injuries to the public.

External appendages are usually cantilevered structures which include eaves, moldings, architectural projecting features, air-conditioning hoods, canopies and balconies, drying racks, projecting panels and claddings. Although the structural designs of these elements have already catered for their cantilevered performance, lack of maintenance and repair of combat, natural weathering would attract development of defects, unduly shorten their lifespan and eventually result in collapse.

Common defects that have seen on doors, windows and external appendages are: Cracking at junctions, Bulging (gaps occurring between finishes and paint, wall) or peeling-off of finishes, spelling of concrete or uncovering of steel, reinforced rusting of metal parts, damage by fungus or vegetation growth, water seepage through the features, corrosion or loosening of attachments (Rojer, 2005).

2.4.8. *Defects in Building Services Installation*

Services installations have a relatively shorter life span than the building structure. Defects in the mechanical components usually lead to failure requiring repair or servicing. It is therefore necessary to have a planned schedule for foreseeable servicing and replacement of components. Avoid exhausting the designed lifespan of such components can prevent sudden breakdown of services that

causes undesirable or even disastrous consequences. Common defects in building services installations are water supply (such as blockage or leakage of components of the pipes or valves, rusty pipes, pump failure, breakage of supply pipe, defective water tanks, defective pipe joints or valves, leakage in the system after water meters),fire services (such as alarm wiring defect, short circuit, inadequate protection or poor management, inadequate maintenance), electricity supply (of fuse or circuit breaker, earth leakage, overloading, uneven distribution of phase set.), lift and escalator, air conditioning / heating (such as poor efficiency, leakage of refrigerant dust and dirt of heat, loosen parts, blowers or propellers breakage, insulation failure).

2.5. Causes of Building Defects

In Weldon, (1998) States that building defects or failures may arose due to a variety of factors, including poor design, failure of the material, poor workmanship, and lack of maintenance. And in (Rhodes & Smallwood J.J., 2002) the causes of defects can be related to design, construction, procurement and prevailing environmental conditions. They also describe the origin of defects as being inadequate management and technical skills.

In addition, (Jeremy, 2006) by far the greatest numbers of claims made by employers or subsequent building owners are such defects claims. The courts have recognized that construction defects are mostly tangible (though often once latent) and can typically be grouped into the following four major categories;

1. Design deficiencies;
2. Material Deficiencies;
3. Specification problems; and
4. Workmanship deficiencies.

N.H. Che Hasim, (2015) states that it has been found that unskilled worker is the most important factor that contributes to the causes of defects occurred regarding the technical causes. Meanwhile, ineffective planning and scheduling and lack of systematic supervising are the most important causes of defect occurred regarding the management. Accordingly, Causes of defect occurs by technical, Unskilled worker, Improper installing elements, Use of substandard materials, Failure to maintain properly, Noncompliance specifications, Weakness of design, Abuse/misuse of buildings, Improper site condition survey. Moreover, defects can also occur by management, Ineffective planning, Lack of systematic supervising and Lack of quality management.

According to Ojo, (2010 Cited inMarianne, 2005) the records of Housing Finance Corporation the defects reported from 1997 to 2006 has been related to design deficiencies, construction deficiencies, Material Deficiencies and subsurface problems. According to the records of Housing Finance

Corporation the defects reported from 1997 to 2006 has been related to design deficiencies, construction deficiencies and subsurface problems. Table below shows the percentage records of reported defects within the period.

Table 2.1:- Defects Reported by Occupies- 1997 to 2006 (Ojo, 2010)

Types of Defects reported	% Reported on yearly basis									
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Design Deficiencies	16%	13%	22%	18%	21%	15%	28%	22%	32%	16%
Material Deficiencies	32%	19%	22%	37%	28%	24%	12%	8%	9%	6%
Construction Deficiencies	45%	36%	44%	41%	39%	48%	51%	28%	12%	26%
Subsurface/Geotechnical Problems	7%	32%	12%	4%	12%	13%	9%	42%	47%	52%

According to Bedru, (2015) mentioned Defective material takes the next role by causing almost 20 percent of construction defects. Deign error were cause just more than 15 percent of construction defects and the remaining defects were caused by poor subsurface investigation and improper usage of building services,

According to Mosisa Alemu, (2016) Generally, the major contributing causes of defects are weakness in design, poor workmanship, and low quality material. Furthermore, these defects are also due to a lack of awareness by occupants about the maintenance of their houses.

2.5.1. *Design Deficiencies*

According to (Yebichaye, 2016) stated Buildings and systems designed by engineers do not always work as specified; this can result in a defect. Typical design deficiencies relate to buildings outside the specified code. A common design error is often made, usually in an effort to save initial construction costs. Project cost plays an important role in designing buildings. Reducing the size of columns, the size of reinforcement bars and foundations are the most common design error in construction. This situation will lead to uncertainty situation in the future where the structure cannot withstand the load and finally fails. Sometimes faulty design is also a result of misjudgment, leading to assumptions or decisions that are not consistent with the actual behavior of the structure.

Design professionals, such as architects or engineers, who design buildings and systems do not always work as specified, which can result in a defect. Typical design deficiencies relate to building outside of the specified code. Roofs are an example of a typical design defect that results in water penetration, intrusion, poor drainage, or inadequate structural support. In Bedru, (2015) refer to Lack

of communication between designer and contractors could be one of the factors that design errors to be created.

2.5.2. *Material Deficiencies*

Yebichaye, (2016) Describe that the use of inferior building materials can cause significant problems such as windows that leak or fail to perform even when properly installed. Materials may easily be damaged during transportation, loading and unloading, inappropriate condition of storage on site and placing in position even though the materials may be flawless upon leaving the factory. The defects can be prevented with by taking greater care during all the stages during the construction project, providing appropriate training to all the workers and staffs, and ensuring closer supervision.

In addition Bedru, (2015) stated that the use of standard materials helps in reducing defects caused due to inferior building materials. For example, for well-proportioned mix ratio selection of aggregates that are hard, rough, mineral free and well graded maintains the required strength, density, porosity, workability and curing time of concrete for the intended purpose. Thus, problems such as cracks caused due to shrinkage and/or overstressing can be hold within limits. Leakage of slab floor, delamination or worse collapse due to low concrete quality can be controlled.

In N.H. Che Hasim, (2015) mentioned that material deficiencies for example window leaks problems can cause failure or performance when using weak materials.

2.5.3. *Poor Workmanship*

According to Gibbon (2010), poor workmanship in housing construction, poor management and control of building contractors has contributed to the housing problem. The installation of the roof will need number of skilled workers. If the roof is not installed properly, it is yielded to roof defect such as roof leakage and sagging. The causes of roof defect because the worker may be not having a license, or certificate apart from having a low level of experience. Poor workmanship often leads to delays in projects.

Bedru, (2015) stated that Defects caused due to bad workmanship should be controlled as they can easily be avoided. Hence, problems caused due to low technical skills such as in concrete production mixture segregation leading to low concrete quality/strength, loose tie of reinforcement bars causing misplacement of the bars leading to over stressing of the structure. Service installation materials fitting problem are also caused due to ill workmanship. Fitting problems inadequate design of sanitary pipes can lead to leakage, electrical installation problems and improper fillings around windows and doors frames are also caused due to bad workmanship. These problems can easily be avoided by monitoring the works closely and enhancing technical kills of the labor and providing good working condition.

In addition to that most work men are not professional and not skillful about how to use their work machine, tools and they didn't update their skill. Sometimes the workers doing the actual building work are not careful to take their construction duties, those all error that arises due workman ship can be the result of a contractor not overseeing the building process as they should or simply not caring about the work being done. At other times, even though the contractor was watching the error that happened due to their workmanship problem, in order to save money and time they didn't return back rather use short cut. While short cut solution can work out to the contractor's advantage, but it can be result in a construction defect in the structure.

2.5.4. *Poor Construction Management*

According to Dai et al. (2009) in refer (Yebichaye, 2016) the incompetence management is generally recognized as a major factor of poor construction productivity. He further stated that the management factors may due to the insufficient of supervision on site. In fact, poor supervision on site contributes to the poor workmanship on a construction site and it can be seen on many occasions on the job site. In addition, the ability of management of the construction site is the primary cause that affects labors' daily productivity.

Good construction management and technical skills are necessary to avoid unnecessary contamination and wastage of construction materials. Good management also helps in controlling workmanship errors hence, avoiding defects caused due to bad workmanship. For example organized onsite material management and storage system can avoid contamination of materials such as corrosion of steel or mineral attack of aggregates due to storing area top soil. This avoids problems caused due to corroded steel material; once it is used as a reinforcing material since the steel cannot overcome the tensile stress on the reinforced concrete structure and leading to overstressing of the structure, structural cracks may occur undermining the stability of the whole structure Bedru, (2015).

2.5.5. *Poor Weather Condition*

Dai et al. (2009) stated that the extreme climatic condition is one of the factors that affecting construction labor productivity and workmanship. From the research of Faisal et al. (2006), found that the climate of Saudi is hot and severe during summer that causes some of the construction works very hard to carry out, such as concreting. As a result, the quality of workmanship is affected.

2.5.6. *Subsurface Deficiencies*

Many houses are built on hills or other areas where it is difficult to provide a stable foundation. Lack of a solid foundation may result in cracked foundations or floor slabs as well as other damage to the building. Subsurface conditions that are not properly compacted or prepared may cause problems; these include improper settling to the ground or the shifting of a structure. In (N.H. Che Hasim,

2015) Subsurface Deficiencies usually refer to the stability of foundation, especially to house located on hills.

The causes of defect are divided into natural phenomena, design errors, workmanship errors, faulty materials, procedural errors, failure to maintain properly and abuse or misuse of the building. It is important to recognize the cause of defect for further remedy. Moreover, the types of failure and the consequences of failures due to design faults, failed due to poor workmanship, faulty materials, procedures as failure inducers and poor maintenance (Crocker, 1990).

2.6. Defect liability period

Construction contracts generally stipulate a period after Practical Completion in which the contractor has the obligation to rectify all defects 'discovered', for a period depending on an agreement with the developer and is usually at least 24 month, in order to verify that seasonal changes do not affect the works after completion the construction contractor will remain responsible for the remedy of defects in the works (Delmon, 2009).

The contractor is required to make good at his own cost any defects which appear within this period and which are due to workmanship or materials not in accordance with the contract or to frost damage occurring before practical completion (David, 2002). In most contracts, the Employer will retain either a proportion of the contract sum (cash) or a reduced performance bond as surety for performance of the Contractor's obligations during the defect liability period (Damian, 2016).

The approach employed on receipt of alleged defective building work is to send a representative to assess the building work and then make a decision as to whether the builder has liability for performing rectification work. Damage caused by use or by other contractors is not the builder's responsibility (Defects, Liability and Maintenance Period/online/Email: info@rencon.com.au).

The contractor is expected to be liable for any defects in building project according to standard form of contract, these standard forms usually contain detailed provisions in respect of the employer's remedies in respect of defective works for example according to (Ong, 2005)

i. Defective work to be remedied by contractor
ii. Defective work to be remedied by employer if contractor fails to do so
iii. Employer may agree to a reduction of contract price instead of remedying the defect
iv. Employer may deduct the cost of remedial works from the contract price until the remedial Works are carried out
v. Employer to withhold retention monies, to be released upon issuance of the Certificate of Practical Completion and/or Certificate of Making Good Defects.

In Nicholas, (2012) the current situation in the Standard Form of Building Contract (SBC) 2011 comprises:

Section 2.1 – Contractor's obligations to carry out and complete the works;

Condition 2.30 – Architect or contract administrator to certify when the works are practically Complete;

Condition 2.38 – Rectification period (previously defects liability period);

Conditions 2.32 & 2.37 – Liquidated (or delay) damages. The employer's sole remedy for late Completion;

Condition 3.18 – Defects for the works to be made good at the contractor's cost;

Condition 4.18 – Retention: 5% until practical completion, then 2.5% during the defects Rectification Period;

Condition 4.15 – The final certificate.

2.7. Length of the Defects Liability Period

The initial defects and liability period can vary on projects but commonly contracted for a time period of 6 to 12 months from date of practical completion as outlined in the formal instrument of agreement between the Principal (developer) and the Contractor (builder). This defects liability period will be outlined in the 'Owner's Manual' supplied by the principal on handover (Defects, Liability and Maintenance Period/online/Email: info@rencon.com.au).

In Damian(2016) typically, the defects liability period starts on the completion of the works, which in many contracts will be signaled by the Employer's representative's issue of a practical completion certificate. The actual period will vary depending on the nature of the contract; for straightforward building projects it is usually six or 12months. For complex engineering projects such as a power station, it can be as long as 24 or 36 months. The defects liability clause may also provide for sectional completion.

In (Arends, 2015) the period of time that the principal has to make a claim at common law for damages will depend on whether the construction contract is executed as a deed or an agreement and applicable state legislation. If the construction contract is executed a deed, the principal will have up to 12 years from the date the defect occurs to bring a claim for damages against the construction contractor. If the construction contract is executed as an agreement, this period is up to 6 years.

In (bca_itsupport@bca.gov.sg, 2018) although there are exceptions, most building contracts in Australia prescribe a 12 month defects liability period.

Table 2.2:- Defect Liability Period in Selected European Countries.

Country	Law	Defect liability period
United Kingdom	Defective Premises Act, 1972	6 years from completion of original works or any further works done to rectify defects
Poland	Building Law, 1994	3 years legal minimum warranty for building defects
Portugal	Portuguese Civil Code	5 years from handover for defects likely to cause partial or total destruction of the building
Cyprus	No specific construction provision-common law applies	2 years from the date of occurrence of the defect
Romania	Romanian Civil Code and Law No.10/1995	10 years for hidden building defects & consequential damages Liability for structural and resistance defects lasts for whole useful life of the building
Austria	Austrian Civil Code	3 years from handover—statutory warranty for real estate and construction works
Check Republic	Building Act 183, 2006	3 years statutory building defects guarantee
Estonia	The Building Act, 2003	2 years statutory warranty for construction works
Ireland	No specific construction provision—common law applies	6 years for claims under tort or contract 12 years for claims based on contracts under seal
France	Spinetta Law, 1978	10 years decennial liability
Germany	German Civil Code	5 years from handover 10 years for defects caused by intentional actions
Greece	Law 3212/03 Law 3669/08	10 years for substantial defects
Hungary	Hungary Civil Code	10 years for shell of the building 3-5 years for finishing works and building products of long duration 3 years for main elements of the building
Latvia	Construction Law 1995	2 years from handover legal defects warranty period
Lithuania	Law on Construction	10 years for structural parts of the building 5 years for all other building parts 20 years for defects intentionally concealed

Source: - European Union (2010).

Table 2.3: Defect liability period in selected African countries.

Country	Defect liability period	Research
Nigeria	6 months	(Alejo Ayodele Oluwole, 2012)
Botswana	6 months	Gofhamodimo (1999)
Ghana	12 months	(Lewis Abedi Asante, 2017)

2.8. Purpose of a Defects Liability Period

Damian, (2016) under a construction contract, one of the Contractor's primary obligations is to carry out and complete the works to the standard set out in the contract. The defects liability period is intended to complement this liability by setting out how and when the Contractor must remedy defective work which becomes apparent during the defects liability period. In effect, the defects liability obligation recognizes that defects will arise in the period following completion and includes the obligation to repair those defects in the general obligation to complete the works to the required standard.

The defects liability period provides a practical mechanism to the Employer for the repair or making good of defects which may not be apparent before completion, without resorting to dispute resolution. Making the Contractor responsible for carrying out the repairs is usually cheaper and more efficient than either the Employer repairing the defect itself or engaging a third party to repair the defect.

In most contracts, the Employer will retain either a proportion of the contract sum (cash) or a reduced performance bond as surety for performance of the Contractor's obligations during the defect liability period. Similar to (Arends, 2015) A defects liability period can help both the principal and the construction contractor in managing their respective risks under the construction contract. From the principal's perspective, a defects liability period is useful for the following reasons:

- Even if minor defects in the works exist, a defects liability period can help the principal get comfortable with the grant of practical completion and taking over of the works in the knowledge that the construction contractor has an obligation to remedy any punch list items and any defects that come to light during the defects liability period;
- It ensures that the construction contractor is incentivized to perform the works to the required standard as it will not be entirely off the hook once practical completion has been achieved; and

- The principal does not have the added burden of managing the interface risk and added cost that would result from engaging a third party contractor for defects rectification work. Any new contractor will be unfamiliar the original construction work and will need to devote time and resources to familiarizing itself with these, the nature of the defect and the best method of rectification.

From the construction contractor's perspective, a defects liability means:

- that payment of any final milestone payment (which can often be sizeable) or final progress claim which it is entitled to be paid is not held up by minor defects in the works as it has the ability to rectify these post-practical completion; and
- By carrying out any defects rectification work itself, the construction contractor can take comfort that the integrity of any fitness for purpose warranties or design life warranties it has given under the contract are maintained.

In Anne-Marie, (2011) Defects liability periods - also known as rectification provisions - can be of benefit to both parties.

For the contractor, it is likely to be more economical and efficient for it to carry out remedial works itself than to pay the costs of another contractor hired by the employer. From the employer's perspective, it will not need to hire an alternative contractor to carry out the work, or to carry out the work itself and reclaim the cost. The employer will also not run the risk that any warranties provided by the original contractor may be affected by a third party carrying out works on the site.

If there is a contractual right for the contractor to rectify defects, and the employer either does not notify the contractor that rectification is needed or refuses access to the site, then the employer may be in breach of contract. Case law illustrates, however, that the contractor will not normally be 'let off the hook' if this happens. The employer will still have a claim for the cost of rectifying the defects, but the claim is likely to be limited to the amount it would have cost the original contractor to carry out the works. It will not be able to claim for remedial works or working methods found not to be strictly necessary.

Employers should therefore give careful consideration to the provisions in the contract before hiring a new contractor to carry out remedial works. This is especially important if the contract stipulates that the employer must notify the original contractor that remedial works are needed before it can make a claim for recovery of any costs of rectification.

2.9. Contractor's Right to Remedy Works and Notifications

According to Damian, (2016) another important consideration is determining whether the Contractor has an exclusive right to remedy defects which appear during the defects liability period. From the Contractor's perspective, it is beneficial to have the exclusive right to remedy the defects during the defects liability period as the costs of remedying the defects will be cheaper than paying the Employer the cost of another Contractor performing such works. If the Contractor has an exclusive right to repair defects, an Employer who proceeds to remedy the works without offering the Contractor the opportunity to do so will be in breach of the contract.

The Employer is generally required to give the Contractor notice of the defects as soon as practicable, stating the nature of the defect and supporting evidence. In addition Greenberg Traurig, (2016) stated the construction contractor is responsible to perform the construction work needed to complete the project. The contractor hires the subcontractors who carry out the work (such as ironworkers, plumbers, electricians, carpenters, masons, etc.) and purchases the materials needed for construction. He also must choose how the constructions will be performed – what methods or techniques will be employed to ensure complete, timely and safe completion of the project. The contractor's obligations are defined by the construction contract, which provides the basis for liability if the contractor fails to perform as required. The contractor is required to perform the work fully in accordance with the plans and specifications and in a good and workmanlike manner. Most construction contracts will state these duties explicitly, but even in the absence of specific contract provisions, the law generally implies these duties into every construction contract.

Although a contractor who complies with plans and specifications generally is not responsible for construction defects, an important exception is where the contractor actually knew that a plan or specification was defective. A contractor who knows or should know that compliance with plans and specifications is likely to result in a defect or failure has a duty to bring that deficiency to the owner's attention before performing the work.

Table 2.4:-Rights, Obligations & Remedial Rights of the Contracting Parties, (Zewdu Tefera Worke)

Clauses	**Description of the Subject Matter**	**Employer**	**Engineer**	**Contractor**	**Remarks**
11	**Defects Liability**				
11.1	Completion of Outstanding Work and Remedying Defects				
	Completion of outstanding works & remedying defects & damages in the Works			Obligation	
11.2	Costs of Remedying Defect				
	Covering the costs of remedying defects, if the defects were attributable to the Contractor			Obligation	Due to its design, Plant, Material or equipment
	Covering the costs of remedying defects if the costs	Liability		Remedial	

2.10. Retention Payment in Construction Contracts

Retentions are in the form of a percentage, which is stated at tender stage. Full deduction is deducted from the contractor's total interim valuation for work that has not reached practical completion. One-half of this retention is released when works reach practical completion and the remainder released after the issue of an architect's certificate of making good defects (SHUNET, 2008).

It is usually desirable for the employer to have the right to withhold a certain percentage of the estimated interim payments due to the contractor as computed from the quantity of work completed so that the employer will have a reserve in his undertaking. This gives the employer a sort of hold on the contractor because of the money due to the latter but not yet paid by the employer. Therefore, the contractor will not be encouraged to quit near the end of the job. The withheld money can also be used by the employer towards remedying poor work or any defective work that may appear after the approval of the work and for finishing up of the works if the contractor fails to complete the contract i.e. for security of completion and correction of defective works (SOBEL, 1999).

According to MoWUD 1994 conditions of contract, the interim payment shall cover five items listed in sub-clause 60(1) such as value of permanent works executed, value of materials on site, value of temporary works if allowed on the contract, amounts reflecting any changes in cost as per clause 70, and amounts approved in respect of day works. Then payment shall be subject to retention in the sum

of 10% (reduced to 5% through amendment) of value certified until completion of the works which will be reduced to 5 % (2.5% as per the amendment) at completion of the works to be retained until the expiration of the maintenance period. The retention will include all the above stated items including materials on site. The final half of the retention can also be released to the contractor if the contractor provides an equivalent unconditional bond which shall remain valid for 12months as provided through amendment (MoWUD, 1994); According to (Tessa, 2011) Retention is security held by a procuring contractor to guarantee the performance of a supplying contractor and in particular to safeguard against defects in the event that the supplying contractor fails to satisfactorily rectify them. The security is usually in the form of cash withheld (retained) but is often substituted for a bank guarantee or insurance bond.

Retention gives you peace of mind that a contractor will complete the project in its entirety. If he doesn't, he loses money. A typical home-construction retention plan calls for the withholding of 5 to 10 percent of payment until the work is finished as promised, so that's a decent amount for the contractor to lose if he under performs. Some states limit the amount of retention. In Nevada, for example, you cannot hold back more than 5 percent of the contract amount. You pay the retention when items on the punch list, or the list of items that don't conform to the contract specification, is completed in its entirety. This means you won't get stuck with shoddy finishes or items that are of lower quality than expected.

In Shunet, (2008) stated the retention percentage is normally 5 to 10 %. However, to provide the client with additional security, this figure can be as high as 10% but the effect of a higher retention percentage affects the contractor’s cash How and increases tender figures as its cost form apart of all tender figures.

Generally, the retention is trust money for contractors, and to safe guard their interest contractors have the right to ask the client to place the retention monies in a separate bank account. The retention money so placed protects contractors from financial loss should the client go in to liquidation.

2.10.1. *Amount of Retention Payment*

Shunet, (2008) mentioned that the retention percentage is normally 5 to 10 %. However, to provide the client with additional security, this figure can be as high as 10% but the effect of a higher retention percentage affects the contractor’s cash How and increases tender figures as its cost form apart of all tender figures.

According to Kasiem, (2008) study that the amount of retention money to be maintained at five percent of the certificate amount and resident supervision should be arranged when makes five percent retention money. They suggested this on the ground that it will help domestic contractors in

their liquid cash problem and defects can be handled within this percentage for resident supervised projects. They also added that keeping such amount of cash is not advisable to maintain the progress of public project where the profit that may be earned from such undertaking may range from 5-15%. This means, if retention money is increased to ten percent of the certificate amount, the employer will withhold five percent of the contractor's profit or money after completion of works for the whole of the defects liability (maintenance) period i.e. one year, which is non-helpful for the employer.

Retention money should be raised to ten percent as per MoWUD 1994 conditions of contract depending on the scope, type, and required quality of the project and arrangement of resident supervision on site. Because the quality of works delivered by domestic contractors is decreasing this makes public employers suffering for maintenance during implementation period of the project. Conversely, the percentage of retention money is reduced to 3 percent of the certificate amount.

According to MoWUD 1994 conditions of contract, the retention money to be deducted from payment certificates was ten percent until the completion of works were up on receiving the certificate of completion of works; it would be reduced to half of this amount i.e. Five percent that would remain with the employer for the whole of the maintenance period. This percentage was reduced to five percent of the certificate amount through amendment and now it is in practice with the new PPA conditions of contract.

The amount of retention money can also be handled by considering the outstanding works and extent of defects observed before the certificate of completion of works is issued. So, the five percent retention money limit can be lowered or made upper depending on the outstanding works not completed satisfactorily as recorded on the snag list or by looking at the scope of work required when the contractor requested for temporary acceptance of the project.

The five percent remaining performance bond can supplement the final retention money. It should also be worth mentioning that contractors are legally liable for any failure of the project for ten years from the date the employer enters into occupation. Moreover, according to FIDIC guideline, five percent final amount of retention money is reasonable for big and complex public projects (FIDIC, 1989). Hence, ten percent retention money with the final five percent retained by the employer during the maintenance period could be applied for bigger and complex projects.

For the reviewed international public project undertaken at Addis Ababa (South African Embassy Project), the percentage of retention money is ten percent of the certificate amount and the limit of retention money is five percent of the contract amount so that the employer retains at a higher rate at the early stages of the contract until five percent of the maximum limit. This indicates that employers

take retention money as a binding system at the early stages of the contract as the literature review reveals as well. This is also recommended by one consultant respondent who prefers retention money to be increased to 10 percent of the certificate amount as contractors may front load their tender price (Kasiem, 2008).

2.10.2. *Purpose of Retention Payment*

According to (Shunet, 2008) the purpose for deduction;

- Ensuring that the works will be properly completed and that all defects in the work will be made good.
- Provision of an incentive for the contractor to proceed diligently and complete the works promptly.
- Provision of protection to the client against the effect of the contractor defaulting.
- Serving as a source where the client can deduct monies for recovery of liquidated and ascertained damages and cost of employing others to earn' out variations or to correct defective work.
- Acting as a cushion and defraying some additional costs when the contractor fails to complete in the case of determination or liquidation.
- Enabling a client to pay the nominated sub-contractor and suppliers directly should the contractor fail to pay them.

Generally, the retention is trust money for contractors, and to safe guard their interest contractors have the right to ask the client to place the retention monies in a separate bank account. The retention money so placed protects contractors from financial loss should the client go in to liquidation.

According to the Kasiem, (2008) to assess about Retention Money can be Purpose of Retention Money, Amount of Retention Money and Does 5% Retention Money Oblige Contractors for Correction of Defects? In construction industry, The Amount and Purpose of Retention Money during DLP can be mentioned Retention payment as safeguard money for the employer to make corrections on defective works, and Retention payment will motivate contractors to undertake corrections and remedies for defective work so that they will collect their final retained money.

2.10.3. Amount of Retention Payment in Needed for Correction of Defects

According to Kasiem, (2008) study five percent retention money will not motivate domestic contractors to undertake remedial works during maintenance or defects liability period (DLP) as half of this retention money (2.5 percent of the contract price) is small.

5% retention money sufficiently motivates domestic contractors to undertake correction works. Because 5% performance bond in addition to the remaining half of the retention money which the employer withheld until the maintenance certificate is issued and it is safe for the employer. Furthermore, the contractor is obliged by law and by subsequent blacklisting for failing to correct defects as the contractor has legal obligation to rectify defects and most domestic contractors rectify defects for their goodwill than the collection of the remaining retention money. In addition,

1. it is sufficient amount of money for remedial works even in the events that correction of defects is to be undertaken by the employer
2. most domestic contractors are giving professional services and they need their reputation and recommendation by their employers
3. it promotes proper quality assurance by employers and the engineer for small and large projects which will enhance the capacity and competence of the sector
4. contractors will be blacklisted if they do not undertake correction works which is against their main objective to be free from any litigation history
5. five percent retained amount for one year, if it is increased to ten percent, might be more than the profit that may be gained from most of the public projects where compensation for price escalation is not fully covered
6. in general, the contractor is obliged by law to correct any defects observed in the project

On the other hand, do not support the above views in that five percent retention money does not sufficiently motivate contractors to undertake correction works. Because the final half part of the retention money (2.5% of the contract price) is small; spatially for small projects in which contractors may ignore it. also remarked that it should be equivalent to the cost of correction defects not the percentage of a contract price since employers usually take-over public project where the project might not be substantially completed with lots of defects recorded in the snag list.

Noticing that the guarantee will expire after twelve months, the employer is addressing a number of correspondences concerning this issue where the contractor seems to be “unresponsive so that it will expire”. This will be additional burden to the employer for the follow-up of the correction of the works and maintenance required unless contractors discharge their obligations under the contract without proceeding with legal procedures and repeated correspondences.

2.10.4. Retention Payment were not paid

According to (Department for Business, Energy and Industrial Strategy, (2017) Retention is a percentage of the contract payment value which is held by the construction customer. Half is released at project completion. The other half is released following the expiry of a defects liability period. Holding retention money is a long established way of providing insurance for the effective delivery

of construction work. However, there are a number of issues associated with how retentions work in practice.

There is evidence of frequent late and non-payment of retention monies, and that some of this is for unjustified reasons. Qualitative evidence gathered suggests that unjustified late and non-payment of retention monies appears to a significant cause of issues associated with the practice of holding retentions within the construction sector, and this occurs due to issues around misaligned incentives, market power, information failures, potentially ineffective dispute resolution and inefficient allocation of insolvency risk. There are a number of existing measures which aim to tackle payment issues, but none tackles issues around the practice of retentions directly. The Government is examining whether intervention is needed to reduce the incidence of unjustified late-payment and non-payment of retentions, to therefore help improve cash flow in the construction supply chain and reduce costs.

Provide details of reasons given by clients and contractors surveyed for why retention monies have not been paid. This indicates that there are a range of reasons why retention monies are not being paid, but many others are not clear cut. For example, it is not clear from this survey data alone whether if a ‘dispute arose with a contractor relating with defects’, the client was correct and the money should have been withheld or whether the work had been completed to the standards set out in the contract and the retention should have, therefore, been released.

Reasons why retention monies were not repaid by clients for contractor are Contractor did not return to correct defects; Dispute arose with contractor relating to defects, Contractor’s become insolvent, Contractor did not ask for the money, and Contractor initially asked for the money, but did not pursue it.

Subject to levels of stakeholder engagement, through consultation we intend to gather views from industry on how much of this late and non-payment of retentions is down to retentions being used for their intended purpose and how much is unjustified. However, it will be challenging to draw robust conclusions from this because opinions as to what constitutes ‘justifiable’ or ‘unjustifiable’ can differ depending on the contractor or client perspective.

CHAPTER-THREE

3. METHODOLOGY

3.1. Study Area

The study was conducted in Oromia regional state, Jimma town. The study area is located in Jimma area of Oromia National Regional State. Jimma is located at about 346 Km in the South West of Addis Ababa and has total surface area of 4,623 hectares. The town is divided in to 3Woreda/Higher and 13 Keeble's. The number of households reported in the town is 26,000.The total projected population of the town from 2007 central statistical agency (CSA) census report is 130,254. The town has a temperature that ranges from 20-30 Co and the average annual rainfall of 800-2500mm3and the town has an altitude of 1718-2000m above sea level.

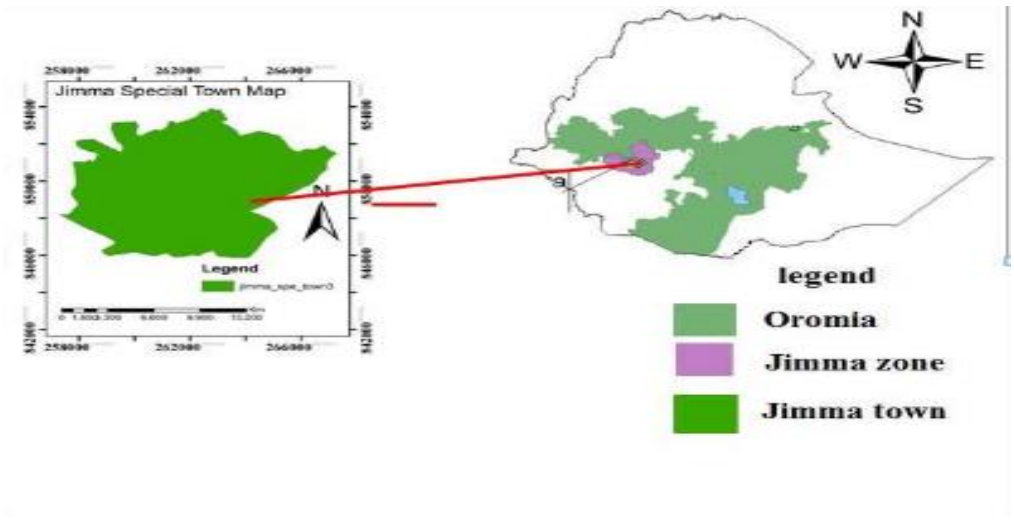


Figure 3.1:- study area

3.2. Study Design

The study employed descriptive survey design; it used both quantitative and qualitative approaches. Quantitative approaches are used to gather factual data and to study relationships between facts and how such facts and relationships accord with theories and the findings of any research executed previously, but the qualitative approach seek to gain insights and to understand people's perception of "the world" whether as individuals or groups (Society, 2012). The related data was collected by *desk study* and using questioners from contractor, consultant and clients who were responsible; having knowledge and experience in construction those include project manager, site engineer, office engineer, residential Engineer, and site supervisor from this parties. After collecting the data, analysis and discussing the Investigation of Defects during Defect Liability Period and Retention Payment on the public buildings construction project in Jimma town.

Table 3.5:- List of investigated projects

No	Project Name	Contractor	Consultant	Project Status
P-1	Work shop & Laboratory building	AFIROTSIYON Construction	Building & Urban Design & Supervision Works Sector	During DLP
P-2	Conference hall	YOTEK Construction	Building & Urban Design & Supervision Works Sector	During DLP
P-3	Mini Stadium	Varinero Impresa Construction	Aspire Aecom Consulting Architects And Engineers	During DLP
P-4	Oxidation ponds, water reservoir	YOTEK Construction	Building & Urban Design & Supervision Works Sector	During DLP
P-5	Dormitory Site work Lot-2	AFIROTSIYON Construction	Building & Urban Design & Supervision Works Sector	Close-out
P-6	Library	YOTEK Construction	Building & Urban Design & Supervision Works Sector	During DLP
P-7	Student canteen	FLINT STONE Construction	Aspire Aecom Consulting Architects And Engineers	During DLP
P-8	Class room & Cafeteria & Clink	RAMA Construction	Building & Urban Design & Supervision Works Sector	During DLP
P-9	Dormitory Site work Lot-2	YOTEK Construction	Building & Urban Design & Supervision Works Sector	Close-out
P-10	Class room Lot-2	Varinero Impresa Construction	Building & Urban Design & Supervision Works Sector	Close-out
P-11	Teaching & Referral Hospital	China Jiangsu International JV with RAMA construction	Building & Urban Design & Supervision Works Sector	During DLP
P-12	Additional facility	RAMA Construction	Building & Urban Design & Supervision Works Sector	During DLP
P-13	Kitchen	Belcon construction	Aspire Aecom Consulting Architects And Engineers	During DLP
P-14	Crime prevention comp project	AFIROTSIYON Construction	Building & Urban Design & Supervision Works Sector	During DLP
P-15	Site Work & Car Shading	YOTEK Construction	Building & Urban Design & Supervision Works Sector	Close-out
P-16	Replacement studio & Laundry	AFIROTSIYON Construction	Aspire Aecom Consulting Architects And Engineers	During DLP
P-17	Jimma zone health office	BEFACON Construction	Building & Urban Design & Supervision Works Sector	During DLP
P-18	Office & Library	AFIROTSIYON Construction	Building & Urban Design & Supervision Works Sector	Close-out

3.3. Study Variables

i. Dependent variable

The dependent variable for this research was defects and retention payment on defect liability period.

ii. Independent Variable

Type of defects, amount of retention payment and Causes of defects were (Design deficiencies, material deficiencies, workmanship deficiencies, whether condition and subsurface deficiencies).

3.4. Population and Sampling Method

3.4.1. Population

The population under study was among the public building constructions and their stakeholders in Jimma town. Hence, samples were drawn from public building construction Projects and the stakeholders in the area in Jimma town. In general, a small proportion of the population was selected as the sample of the study analysis.

Table 3.6:- Population and sampling method

Item No.	Population	Number of data	Sampling procedure	Sample size
1	**Client**			
1.1	Engineering & Construction Department	13	Purposively	12
2	**Consultant**			
2.1	Branch Office manager	3	Purposively	3
2.2	Resident Engineers	8	Purposively	7
2.3	Site Supervisors	8	Purposively	7
3	**Contractors**			
3.1	Project Manager	8	Purposively	7
3.2	Site Engineers	9	Purposively	8
3.3	Office Engineers	9	Purposively	8
	Total Sample Size……	**58**		**52**

3.4.2. Sampling Method

Since Non-probability sampling represents a group of sampling techniques and has free distribution that help researchers to select a unit sample from a population, purposive sampling method was adopted for this study. The study employed the purposive sampling techniques from client, contractor and consultant. Accordingly, Eighteen (18) buildings were investigated for the survey study. The populations of the study are respondents of the questionnaires such as contractors, consultants, and clients as the details are listed in table 3.6 above.

3.5. Data Collection Procedure

Data collection is the accumulation of specific evidence that enables the researcher to properly analyze the results of all activities in the research design and procedures. The main purpose of data collection is to verify the research hypotheses.

Primary and Secondary data were used for this study. The sources of the primary data were in the form of observational checklist and questionnaires gathered from public buildings, clients, contractors and consultants. The main role of the primary data is to collect information that can be analyzed, and arrive at conclusions about the construction defects during defect liability period of public buildings in Jimma town. Secondary data was also used since this study included information from published text such as research journals, books, dictionaries, and internet sources used to compliment the primary data.

3.6. Data Analysis Materials

The main tools of this research is excel and SPSS 20 which the questionnaires were prepared and analyzed. The relative importance index (RII) of Likert 5 scale rating is a means of common type and causes of defects selection. Excel and SPSS 20 were the best tools which were used to perform different analysis.

3.7. Data Processing and Analysis

The interview was conducted using a checklist with 6 items that each interviewee responded on. The questionnaire contains 71 items on construction defects types, and 50 items on causes of construction defect, and 5 questions the retention payment was developed. Then all-inclusive site visit was done on selected seven buildings. For the survey study, a questionnaire of 126 factors was carefully designed from literature conducted in building construction projects. It was organized in the form of a Likert scaling (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree).

The Relative Importance Index (RII) is a statistical method which is used to determine the ranking of different construction defects. As this survey was designed to investigate the relative importance of various major causes of defects, the method was adopted in this study within various groups. The RII five-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree) was adopted and transformed the relative importance indices' for each type and causes of defects as follows;

$$\text{RII} = \frac{\sum W}{\text{A}*\text{N}} = \frac{(1*\text{n1}+2*\text{n2}+3*\text{n3}+4*\text{n4}+5*\text{n5})}{5*\text{N}} \quad \text{.....3.1}$$

Where w is weighting given to each factor by respondents ranging from 1 to 5. (n_1= number of respondents for strongly disagree, n_2 = number of respondents for disagree, n_3 = number of respondents for neutral, n_4 = number of respondents for agree, n_5 = number of respondents for strongly agree). "A"' is the highest weight (i.e. 5 in this case), and N is the total number of respondents.

3.8. Validity Analysis and Reliability Data of the Questionnaires

3.8.1. Validity Analysis

To insure the validity of the questionnaire, two statistical tests were applied. The first test is criterion related validity test (Spearman test) which measures the correlation coefficient between each paragraph in one group and the whole groups. The second test is structure validity test (Spearman test) that used to test the validity of the questionnaire structure by testing the validity of each group and the validity of the whole questionnaire. It measures the correlation coefficient between one group and all the groups of the questionnaire that have the same level of similar scale (Field, 2003).

Spearman's rank correlation coefficient (r) is used to demonstrate whether there is the agreement or disagreement of ranking between any two parties. The spearman's rank correlation is a non-parametric test. The correlation coefficient varies between +1 and–1, where +1 implies a perfect positive relationship (agreement), while –1 results from a perfect negative relationship (disagreement). The Spearman (rho) rank correlation coefficient was used for measuring the differences in ranking between two groups of respondents scoring for various factors (i.e. consultants' vs clients, client's vs contractors, and consultants' vs contractors).

The Spearman (rho) rank correlation coefficient for any two groups of ranking is given by the following formula.

$$\text{Rho } (\rho\text{cal}) = 1 - = \frac{6\sum di^2}{N(N^2-1)} \quad \text{.....3.2}$$

Where:

Rho (ρcal) – Spearman rank correlation coefficient

di– The difference in ranking between respondent for each factors

N– Number of factors (variables)

This was used to check the level of agreement between different groups of respondent during assigning score for different factors of the questionnaire. This was clearly mentioned on the analysis part of the research.

3.8.2. Reliability of Data

Reliability aimed to examine the quality of measurement. One of the most commonly used indicators of reliability analysis was Cronbach's alpha coefficient (Field, 2003) as cited (Mohamed Abo Zeiter, 2017). Cronbach's Coefficient Alpha can be used to check reliability of questionnaire. The normal range of Cronbach's coefficient alpha value between 0.0 and + 1.0, and the higher values reflects a higher degree of internal consistency (Fellows, 2008). The equation used to analyze Cronbach's Coefficient Alpha is:

$$\alpha=\frac{(K*r)}{1+(k-1)r} \quad \text{.....3.3}$$

Where: α = is Cronbach's Coefficient Alpha K = is items (variables) in the scale and r = is the average of the inter-item correlations. The data collected on Design Related Causes of Defects, Construction Related Causes of Defects, Material Related Causes of Defects, and Climatic condition Related Causes of Defects, and Subsurface Related Causes of Defects the value of Cronbach's coefficient alpha analyzed using SPSS v20 and the result is shown in table 4.15 below.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1. Introduction

This Chapter discusses the analysis of the data collected through questionnaires, interview, and site observation in relation to the literature review. The findings are presented using appropriate data presentation tools (tables, graphs, and photos). Hence, from the desk study, eighteen building construction projects, which include 5 close-out projects and 13 still in Defect Liability Period projects, in Jimma town were surveyed. The desk study included the project name, provisional acceptance date; half of the retention payment and project status were investigated.

4.2. Result of Desk Study

Initially this study investigated desk studies. It was to signify the names of selected projects, provisional acceptance date, amount half of retention payment and project status of 5 selected projects that are at the close-out stage, and 13 building construction projects during DLP process as described in table 4.7 below.

Table 4.7:- the results of desk study

No	Project Name	Provisional Acceptance date	2.5% Retention Payment	Defect Liability Period(1Year)	Project Status
P-1	Workshop & Laboratory building	06/06/2018	10,107,667.54	Above 2 years	During DLP
P-2	Conference hall	24/10/2016	8,004,049.09	Above 3 years	During DLP
P-3	Mini stadium	26/11/2018	4,949,951.84	Above 1 years	During DLP
P-4	Oxidation ponds, water reservoir (Site work L-1)	12/06/2016	4,527,440.83	Above 4 years	During DLP
P-5	Dormitory Site work Lot-2	17/09/2012	5,362,607.92	almost 3 years	(08/08/06) Close-out
P-6	Library	23/06/2013	5,208,613.91	Above 7 years	During DLP
P-7	Student canteen	05/07/2018	4,131,851.27	Above 1 years	During DLP
P-8	Class room & Cafeteria & Clink	12/10/2006	3,037,070.825	Above 5 years	During DLP
P-9	Dormitory Site work Lot-2	28/06/2015	7,384,768.24	Above 2 years	(07/03/09) Close-out
P-10	Class room Lot-2	15/03/2015	6,819,910.28	Above 1 years	(03/10/07) Close-out

P-11	Teaching & Referral Hospital	28/01/2015	9,650,818.68	6 years	During DLP
P-12	Additional facility	21/03/2017	8,675,432.14	Almost 3 years	During DLP
P-13	Kitchen (Supplementary work)	19/09/2017	246,799.25	Above 2 years	During DLP
P-14	Crime prevention comp project	27/08/2015	3,451,275.63	Above 4 years	During DLP
P-15	Site Work & Car Shading	15/04/2014	2,868,577.46	Above 1 years	(03/10/07) Closed-out
P-16	Replacement studio & Laundry	21/07/2016	13,778,698.74	Above 3 years	During DLP
P-17	Jimma zone health office	11/06/2019	275,000	9 months	During DLP
P-18	Office & Library	29/01/2015	886,194.09	3 years	(29/09/10)Closed-out

Although the defect liability period stated in the construction contract document is 1 year (12 months), the above desk study result shows that the defect liability period extended over one year. Hence, 12 projects are still not close-out and the Defect Liability Period was extended to 2 to 7 years due to various reasons, so the employer has not released the 2.5% of retention payment to the contractor for rectifying the defects. 5 projects are closed-out within 1 to 3 years of defect liability period. 1 project is not closed-out because the DLP is under one year.

4.3. Site Observation

Currently, the researcher identified the following defects during the site observation period.

4.3.1. Improper finish Tiles and Slope of Floors

As shown below in Figures 4.2 and 4.3, the floors of the Mini stadium and Library building projects have been finished with improper tiles and Slopes. Floor finishes of tiles have not properly sloped; these were one type of defect in public building construction projects especially happened in toilet and shower rooms due to this problem the wastewater could not going forward into the floor drain or ditch. These types of defects occurred due to subsurface level deficiency and poor workmanship. This shows that poor workmanship is the most serious cause of this type of defect. The results revealed that there was inadequate workmanship and weak follow up during the construction stage of the construction to attain proper quality.

Figure 4.2:- Defective Floor finishes in main entrance

Figure 4. 3 :- Defective Floor finishes in Toilet & Shower room

4.3.2. Peeling off paint

Figure 4.4 shows peeling off paint defects in the wall of the building that are frequently observed in the conference hall project. This problem has been usually seen on public building constructions during the defect liability period, mainly occurred on the plastered wall, slab, columns, and other areas that are unprotected to excessive rain and great dampness that are visible on the interior wall in Jimma town. Such defects happen most often due to improper preparation of the surface before painting, apart from that moisture surrounding since the walls seep in through from the wall to the paint surface.

(a) *(b)*

Figure 4. 4: (a & b) peeling off paint in the slab and wall

4.3.3. Cracking in Plastering

Figure 4.5 shows cracking defects in plastering walls of the public building that are observed in mini stadium and Jimma health office building projects. This defect occurred due to unskilled workers and inadequate curing periods. Cracking in plastering commonly shown on public building construction during defect liability period, mainly happened on plastered walls and columns due to poor workmanship, improper curing of the plaster, and incorrectly mixed cement mortar ration. The plasters can also become cracks early and develop a series of cracks throughout the surface due to not following the plastering procedural method during the cement mortar plastering period.

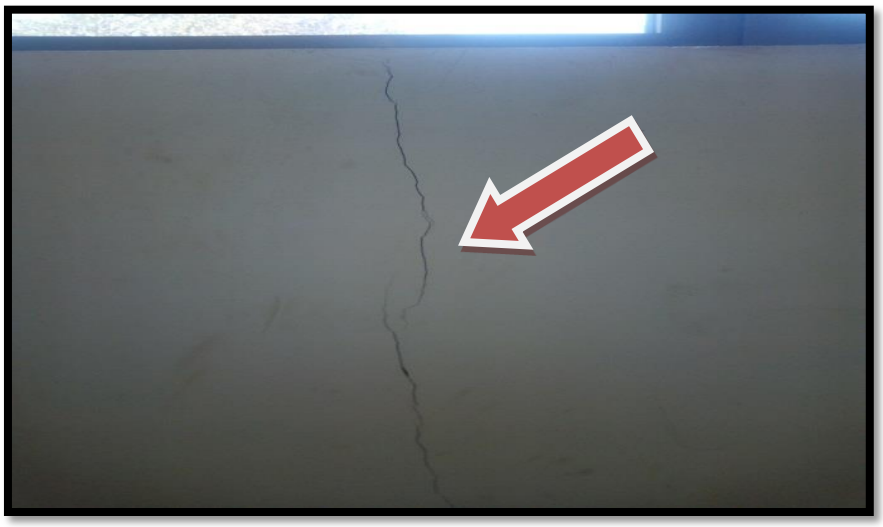


Figure 4. 5: cracking in plastering

4.3.4. Damp/leakages in ceilings

Figure 4.6 shows, Leakages in ceiling that usually happen on the ceiling of the building.

Figure 4. 6 : Leakages in ceilings

Leaking in-ceiling manifestly occurred in conference hall building construction during the defect liability period, the major problem of this defect is water leaking from the roof. These problems may appear during DLP and/or in a long period of time after closing-up the project, with water leaking from the roof into the ceiling in just minute drops through a line.

4.3.5. Door Handling Damaged

Figure 4.7 & figure 4.8 shows, handling damaged occur on doors are the handling problems which are damaged or not working which leads to being a difficult in for the most part of the door due to used low-quality sub-standard materials and not fixed or missing the handling door and key by the contractor . These defects of door handling damage were showing during the defect liability period in Library and conference hall building construction due to this problem the employers of more compliance about the quality, strength, and durability of door handling material. These reasons to used low-quality standard materials and during DLP the users are damage by carelessness.

Figure 4.7:- missing of Handling & key

Figure 4. 8:- Handling damaged of metal door

4.3.6. Water seepage through windows

Water seepage through windows is the issue of defects for windows of buildings which shows due to poor workmanship not properly fix the window.

As shown in figure 4.9 & figure 4.10, Water seepage through windows during the Defect Liability Period mostly has been happened in conference hall buildings construction in Jimma town. Totally, Water seepage through windows is occurred due to poorly installed windows. These defects occurred

to damage the interior public building like mold and mildew growth and peeling off paint..

Figure 4. 9:- water seepage through top window

Figure 4. 10:- water seepage through side window

4.3.7. Damage and Leakage of roof

Jimma Town public building constructions used different types of roof coverings Some of them are concrete flat roof, Galvanized iron sheet (GIS) roof covering, and skylight roof covering, on these type of roof coverings are most of the time could occur leakages of roof defects by gutter clogged up with debris, properly not covered by ridge cap and roof flashing or roof membranes can leak from poor installation and skylight is frequently broken or damaged because of using low-quality material standard.

Figure 4.11 – 4.13 shows, Leakages of roof that are a common problem in Mini Stadium, Library and conference hall building, caused by poor workmanship and using defective material on the roof during the construction stage as well as after Defect Liability Period. These problems brought about roof leakage, which is a breeding ground for black mold, damaged interior ceilings, and walls, and decay of the wooden framing.

Figure 4. 11: defective roof tiles

Figure 4. 12: Broken roof of skylight

Figure 4.13: Leakage in flat roof

4.3.8. Sanitary fitting damaged/broken

Figure 4.14 shows sanitary accessories damaged or broken in the building construction that are observed in the library in the toilet and shower room buildings. Most of the time, the sanitary fitting damaged/broken that happen in building construction in Jimma town during the Defect Liability Period occurred due to the use of sub-standard material quality, and improper installation by a plumber, and due to users' damage. Consequently, these damaged sanitary accessories can cause water leaks through sanitary fixtures defects such as cracks and peeling off paint surfaces in building constructions.

Figure 4.14: Sanitary accessories broken

4.3.9. Short Circuit in Breaker

The electrical circuit breaker is a switching device that can be operated automatically or manually for controlling and protecting the electrical power system, and that the flow of electricity is cut off to keep your circuits from overheating or causing more damage.

Figure 4.15 shows, Short circuits breaker in public building constructions are common defects that are observed frequently. Short circuits could occur for a number of reasons such as faulty wiring, loose connection, not using a standard specification of the power cable and neutral wire (line) activate by power because of losing. In the library and conference hall building construction, the

short circuit breaker occurred during the Defect Liability Period. All the above might be caused by using low-quality materials standard, poor workmanship during installation, poor control, and supervision.

Figure 4.15: Short of circuit Breaker

4.3.10. Unbalanced power distribution on phase

In mechanical works usually happen electrical faults and unbalance distribution phase by the excess load on electrical wire, too much electrical load on the circuit, tightly packed wiring in the main electrical box, and lose connections inside the main pane. The electrical faults causes are due to poor installations or regular wear-and-tear.

Unbalance power distribution on phase defects occur in the neutral & breaker connections within the main electrical panel loose connections due to incorrect installation by causes of poor workmanship and design faulty, these results could not properly use the mechanical works in public building construction in Jimma town during defect liability period as shown below figure 4.16.

Figure 4.16: Uneven distribution of phase repair

4.3.11. Lift machine is not fixed/ installed

Lift machines are very essential to provide vertical circulation in high buildings. These are used to transport people and goods from one floor to another.

Figure 4.17, the two Lift machines are not fixed in the student canteen building construction which observed during the defect liability period. The reason for this problem is poor project management, lack of attention, and poor planning of schedule during the construction stage and during DLP. Due to this problem, the owners complain to the contractor to fix the machine during the defect liability period.

Figure 4.17: the contractors not yet fix the lift machine

4.3.12. Faulty wastewater drainage system

Wastewater may be conveyed in a sanitary sewer that conveys only sewage. Also, wastewater can be transported in a combined sewer that conveys both storm water runoff and sewage, and possibly also industrial wastewater.

Figure 4.18 shown, that defects occurred in mini-stadium public building construction in Jimma town. The cause of this defect of the design missing defects due to not consider the pipes or drains which have an insufficient diameter of drains.

Figure 4.18: Faulty drainage wastewater

4.2.13. Leakages in Down Pipe and Cracking in Exterior Wall after Defect Liability Period

Downpipe is a pipe that is used to direct rainfall away from a building, usually from roof guttering to drainage to as a downspout, drain spout, roof drain pipe. There are a number of reasons to downpipes leak that becomes blocked, start overflowing at joint, poor workmanship and faulty design. At shown Figure 4.19 the defects downpipes leak in the roof observed in site work and car shading public building after the defect liability period. This defect needs immediately rectify the defects by the owner.

In addition Cracks in exterior wall defect in a structural element of a building that commonly occurs in building construction such type of crack may be caused by many factors, excessive movement of the building structure, unwanted ground settlement, serious overloading, and deterioration of materials, poor design/ construction. At shown Figure 4.20 the defects cracking in the exterior wall observed in student dormitory public building construction after the defect liability period. This defect needs immediately to rectify the defects by the owner.

Figure 4.19:- downpipe leak in roof

Figure 4.20:- cracking in exterior wall

4.4. Population Characteristics

This part contains the most important information about the respondents in terms of the name of organization, position, educational, and experience of contact person.

4.4.1. Type of organization and response rate

In this study totally 58 questionnaires distributed for three companies. Thus, 22.41% (13) of the participants were clients, 44.83% (26) were contractors, and 32.76% (18) of them were consultants. The questionnaires response rate were in percentage for client 23.08% (12), contractors 44.23% (23) and consultants were 32.69% (17) and the total numbers of respondents for the three companies were 52. The response rate of contractors was 88.46 % (23 out of 26 respondents), for the client's 92.30 % (12 out of 13 respondents) and 89.47 % (17 out of 19 respondents) for consultants.

Table 4.8 Response Rate of the Questionnaire by Organization

Organization	Distribution in No	Response in No	Response rate in percentage
Client	13	12	92.3%
Contractor	26	23	88.46%
Consultant	19	17	89.47%
Total	**58**	**52**	**89.65%**

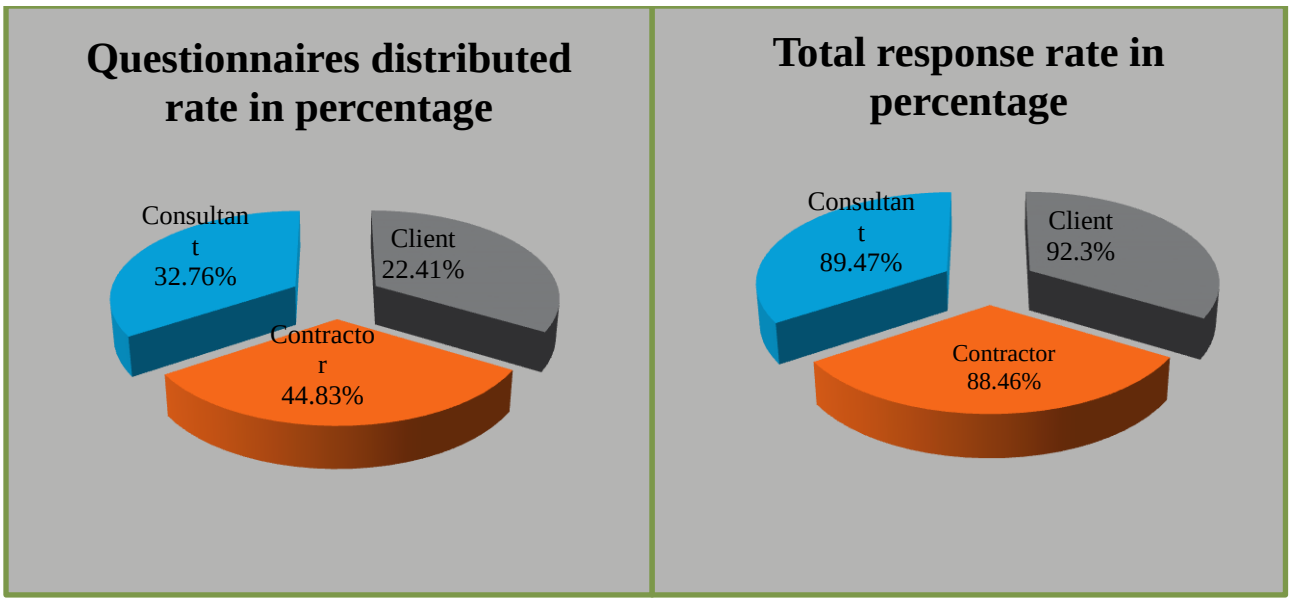


Figure 4.21: Respondent's organization

4.4.2. Grade of Contractor Companies and Engaged Of Contractor

Grades of contractor companies and Engagement of contractor are presented in this section. Contracting companies are 82.60% of general contractor (GC) Grade-1 local contractor and 8.70% of building contractor (BC) Grade-1 local contractor, and 8.7% General Contractor (GC) Grade-1

foreign contractor. As illustrated in Table 4.9, totally, Grade one contractors were involved in these project sites.

Table 4.9 Grade and engaged of Contractors

Grade of company		Company Engaged	Number	Percent
Grade – 1	GC-1	Local Contractor	19	82.60%
	BC-1		2	8.70%
	GC-1	Foreign Contractor	2	8.70%
Total			**23**	**100%**

4.4.3. Respondent of Job Position

Fifty-two (52) respondents from the three parties (contractors, clients and consultants) participated in this study. Among them, 23.08% (12 out of 52) of the clients party were in the Engineering & Construction department; 13.46% (7 out of 52) were project managers, 15.38% (8 out of 52) were site engineers and 15.38% (8 of 52) were office engineers, 5.77% (3 out of 52) were Project Coordination office head, 13.46% (7 out of 52) were Resident Engineer and 13.46% (7 out of 52) were Site Supervisor.

It has been found 92.31% (12 out of 13) of client party were Engineering & Construction department. it has been found that 88.46% (23 out of 26) contractors company's respondent 30.43% (7 out of 23) were project manager, 34.78% (8 out of 23) were site engineer, 34.78% (8 out of 23) were office engineer. 89.47% (17 out of 19) of consultant's company's respondent 17.65% (3 out of 17) were Project Coordination office heads, 41.175% (7 out of 17) were site supervisors, and other 41.175% (7 out of 17) were residential engineers.

Totally as we have seen in table 4.10It has been found 23.08% (12 out of 52) of client Company's party respondents participated; 44.23% (23 out of 52) Contractors Company's respondent participated, and 32.69% (17 out of 52) of consultant's company's respondent participated.

Table 4.10:- Respondent Job position

Job position	Frequency	Percent
Engineering & Construction department	12	23.08%
Project Manager	7	13.46%
Site Engineer	8	15.38%
Office Engineer	8	15.38%
Project Coordination office head	3	5.77%
Resident Engineer	7	13.46%
Site Supervisor	7	13.46%
Total	**52**	**100%**

4.4.4. Educational Level of Respondents

The respondent's Educational level is shown in Figure 4.22 below. 22 (42.31%) of respondents were Graduates (MSC holders), 29 (55.77%) were under Graduates (BSc holders) and 1 (1.92%) of them secured Advanced Diploma. Generally, the 98.1% of the respondents secured MSC and BSc. This indicates that the respondents had great confidence in their answers.

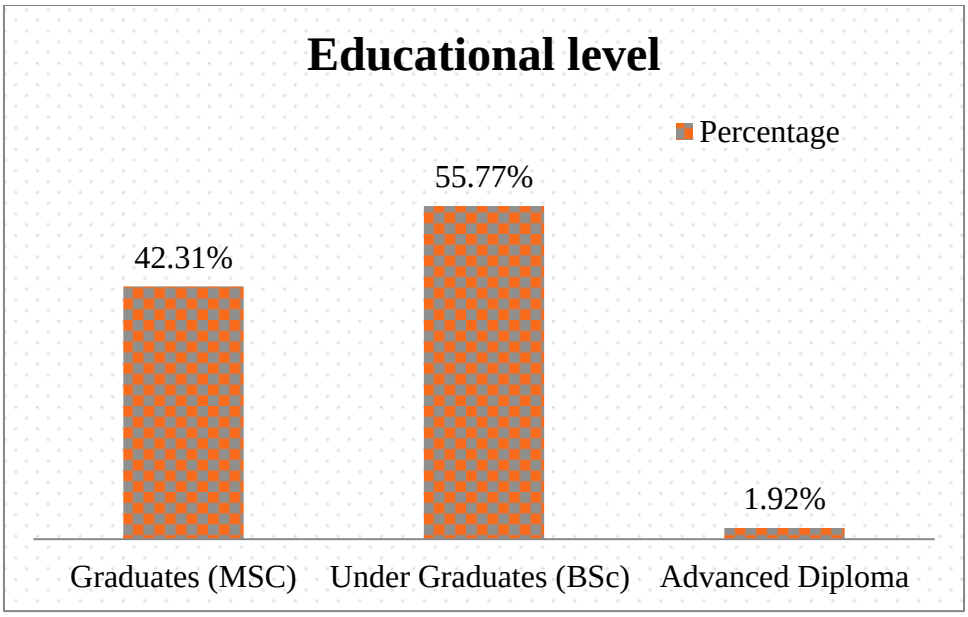


Figure 4.22: Number & Percentage of respondent Education Background

4.4.5. Years of Experience in Construction Industry and Building Construction

Figure 4.23 represents the distribution of respondents by their years of experience in the construction industry. 10 respondents have less than 5 years' experience at construction works, 22 respondents have experience between 5 to 10 years, 14 respondents have from 10 to 15 years' experience, 5

respondents have from 15-20 years' experience, and 1 respondents have more than 20 years' experience in the field.

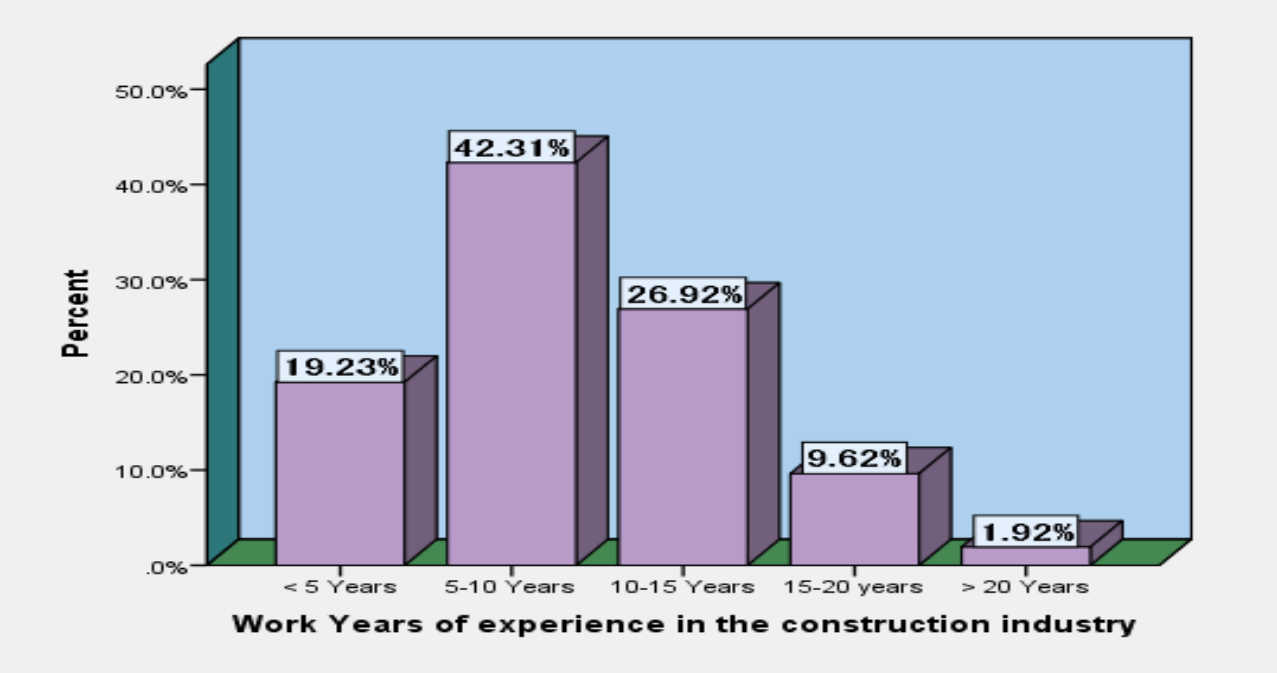


Figure 4.23: Percentage of respondent experience

Figure 4.23 shows that 42.31% of the respondents have 5-10 years' work experience in building construction projects. This reveals that the respondents were experienced on building construction projects. For that reason, it can be accomplished that the result from the survey is relatively accurate and reflects the actual situation in the public building construction projects with respect to the focused the types and causes of defects during defect liability period and retention payments on the standard condition of contract together with its inferences. Further, considering the reasonably high experience of the respondents and the number of responses, the data obtained from the survey cover a full of information that can help to illustrate reliable conclusions and recommendations.

4.5. Findings from the Questionnaires Types of Defects during Defect Liability Period

The construction defects in the building construction could take place during defect liability period and after defect liability period. This section includes results about the frequent types of building defects in public buildings collected from the questionnaires, interviews, and site observation.

The questionnaires of these studies deliberate on 11 subtopics include 71 items frequent types of building defects seen during defect liability period. The respondents were required to determine how frequently the listed defects occurred in public building construction projects in Jimma town. This type of defect occurs in Floor, Wall, Ceiling, Door, Window, Roof, Toilet and Shower, Glazing, Sanitary work, Electrical work, Mechanical work (See Annex-1 in section-1).

Respondents were required to determine how often frequently the listed defects occurred in public building construction projects in Jimma town. So their responses are stated according to the three groups of respondents, and discussions are made based on the relative importance index (RII) of clients, consultants and contractors. In this research defects which have a RII of less than 1 (RII≤1) are considered as the most common types of defects observed by the respondents.

4.5.1. Ranking Types of Defects among those Target Groups Consultants Group

As stated in Table 4.11 main ten defects were ranked from the consultants group responses the in accordance to RII value among the 71 types of defects that occurred during Defect Liability Period. Accordingly, leakage in roofs has been indicated the first position with RII= 0.889 value. Damp/leakages in ceilings has been ranked by the second position with RI= 0.859 value. Peeling off paint and Seepage from defective pipe works or sanitary fixture have been ranked in the third position with RII= 0.850 value. Plastering Cracks has been ranked in the 5th position with RII= 0.824 value. Handling damaged has been ranked the in the 7th position with RII= 0.823 value. Sanitary fitting damaged and Uneven distribution of phase have been ranked in the 8th position with RII= 0.8235 value. Broken or leaking sanitary fixtures has been ranked in the 10th position with RII=0.822 value. The ranks of other type of defects were shown from table 4.11.

Client's Group

The main ten defects according to clients' group responses are in addition revealed in Table 4.11 in accordance to RII value. Hence, leakage of roof has been ranked in the first position with RII= 0.900 value. Damp/leakages in ceilings has been ranked in the second position with RII= 0.883 value. Peeling off paint has been ranked in the third position with RII= 0.863 value. Plastering Cracks has been ranked in the 4th position with RII= 0.843 value. Broken or leaking sanitary fixtures has been ranked in the 5th position with RII= 0.841 value. Seepage from defective pipe works or sanitary fixture of phase has been ranked in the 6th position with RII= 0.840 value. Handling damaged has been ranked in the 7th position with RII=0.8398 value. Short circuit Breaker has been ranked in the 8th position with RII=0.839 value. Water seepage through windows has been ranked in the 9th position with RII=0.838 value. Sanitary fitting damaged/broken & uneven distribution of phase have been ranked in the 10th position with RII=0.837 value. The ranks of other defect types were as shown in table 4.11 below.

Contractor's Group

Defects in the building that occurred during Defect Liability Period were ranked by contractors, and values are recorded according to the respective *relative importance index* (RII). Hence, Leakage of roof has been ranked in the first position with RII= 0.891. Short in circuit Breaker has been ranked in

the second position with RII= 0.838 value; Seepage from defective pipe works or sanitary fixture has been ranked in the third position with RII= 0.830 value. Peeling off paint has been ranked in the 4th position with RII= 0.828 value; Plastering Cracks has been ranked in the 5th position with RII= 0.827 value; Damp/leakages in ceilings has been ranked in the 6th position with RII= 0.826 value. Water seepage through windows has been ranked in the 7th position with RII=0.825 value; Broken or leaking sanitary fixtures has been ranked in the 8th position with RII=0.824 value; Handling damaged, Sanitary fitting damaged/broken and Uneven distribution of phase have been ranked in the 9th position with RII=0.822 value. The ranks of other defect types are shown in table 4.11 below.

Table 4.11:- Relative Importance Index and Ranks for types of defects during defect liability period

Type of Defects	Consultant		Clint		Contractor		Average Weight	
1. Floor	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**
Uneven or irregular floor finishes	0.783	20	0.767	27	0.744	25	0.765	25
Seepage from defective pipe works or sanitary fixture	0.850	3	0.840	6	0.830	3	0.840	4
Broken floor tiles	0.635	63	0.683	49	0.548	68	0.622	62
Defective skirting	0.671	54	0.617	61	0.348	71	0.545	71
Dampness in floors	0.776	24	0.650	52	0.730	28	0.719	40
Crack floor	0.682	51	0.757	30	0.626	58	0.688	47
Detached floor finishes	0.706	46	0.763	28	0.729	31	0.733	35
Floor finishes not closely	0.565	70	0.550	70	0.591	61	0.569	68
2. Wall								
Water penetration through external wall defects such as cracks and joints	0.706	46	0.833	13	0.713	34	0.751	28
Wall Cracks	0.765	31	0.827	15	0.747	24	0.779	19
Plastering Cracks	0.824	5	0.843	4	0.828	5	0.832	6
Wall surface rough	0.635	63	0.717	42	0.470	70	0.607	66
Peeling off paint	0.850	3	0.867	3	0.828	4	0.848	3
Broken wall ceramic tiles	0.694	49	0.633	57	0.730	28	0.686	48
Detached of ceramic wall tiles	0.694	49	0.733	38	0.730	28	0.719	38
3. Ceiling								
Broken ceiling	0.768	29	0.837	10	0.786	15	0.797	14
Damp/leakages in ceilings	0.859	2	0.883	2	0.826	6	0.856	2
Uneven ceiling	0.753	35	0.700	47	0.683	44	0.712	43
Ceiling and wall joint separation	0.738	39	0.567	69	0.635	55	0.647	57
Peeling of point	0.753	35	0.817	18	0.762	20	0.777	21
4. Door								

Water seepage through doors	0.671	54	0.618	60	0.656	49	0.648	56
Damaged door leaf	0.720	43	0.637	56	0.678	45	0.678	51
Door not tight closed	0.765	31	0.667	50	0.744	27	0.725	36
Door too tight	0.708	45	0.650	52	0.722	32	0.693	45
Door frame tilt/damaged	0.624	65	0.633	57	0.635	55	0.631	61
Handling damaged	0.824	6	0.840	7	0.822	9	0.829	8
Key damaged	0.771	28	0.752	32	0.753	23	0.759	26
5. Window								
Water seepage through windows	0.821	12	0.838	9	0.826	7	0.828	9
Window not close	0.661	57	0.613	63	0.635	55	0.636	59
Tight window	0.662	56	0.617	61	0.652	50	0.644	58
Rubber on window ripped	0.682	51	0.650	52	0.678	45	0.670	52
Window frame tilt/damaged	0.659	58	0.600	64	0.638	54	0.632	60
Window lock damaged/malfunctioning	0.800	16	0.817	19	0.687	42	0.768	24
6. Roof								
Leakage of roof	0.889	1	0.900	1	0.891	1	0.893	1
Roof tiles tear off	0.801	15	0.783	23	0.754	22	0.779	20
Broken/Damage skylight	0.782	23	0.783	24	0.764	19	0.776	22
Damage or deterioration waterproofing membranes	0.788	17	0.800	21	0.769	16	0.786	16
7. Toilet and Shower								
Toilet/sink clogged	0.680	53	0.650	52	0.617	60	0.649	55
Toilet pump damaged	0.647	60	0.633	59	0.580	64	0.620	63
Shower tap damaged	0.765	31	0.740	35	0.717	33	0.741	31
Leaky pipes	0.788	17	0.800	21	0.759	21	0.782	17
Sanitary fitting damaged/broken	0.823	8	0.837	10	0.822	9	0.827	10
Floor trap clogged	0.788	17	0.780	26	0.744	25	0.771	23
Clogged water closet	0.782	22	0.713	46	0.710	38	0.735	32
8. Glazing								
Brocken Glazing	0.718	44	0.727	39	0.713	34	0.719	39
Improper fillings putty/stucco	0.608	66	0.533	71	0.557	67	0.566	69
9. Sanitary work								
Insufficient water pressure or flows	0.600	67	0.600	64	0.584	62	0.595	67
Defective pipe joints or valves	0.824	7	0.823	16	0.765	17	0.804	12
Leaking downpipe	0.771	27	0.782	25	0.794	12	0.782	18
Defective wastewater drainage system	0.801	14	0.821	17	0.786	14	0.803	13
Broken or leaking sanitary	0.822	10	0.841	5	0.825	8	0.830	7

fixtures								
Blocked drains system	0.742	37	0.750	33	0.713	34	0.735	33
Pump failure	0.783	20	0.733	36	0.686	43	0.734	34
10. Electrical work								
Electrical switches or outlets not working	0.741	38	0.753	31	0.764	18	0.753	27
Lift failure/stoppage, unstable lifting	0.553	71	0.583	68	0.560	66	0.565	70
Loose junction boxes for switches or convenience outlets	0.729	41	0.717	40	0.701	41	0.716	42
Poor sound system installation	0.733	40	0.743	34	0.671	47	0.716	41
Insufficient fire prevention or protection mechanism	0.600	67	0.600	64	0.652	50	0.617	64
Fire alarm not working	0.766	30	0.760	29	0.704	39	0.743	29
Electric sparks or shocks, electrocution	0.659	58	0.717	40	0.670	48	0.682	50
Short in circuit Breaker	0.822	11	0.840	8	0.838	2	0.833	5
11. Mechanical work								
Not cool enough, not warm enough	0.815	13	0.833	14	0.574	65	0.741	30
Engines sound normal but no air movement	0.600	67	0.600	64	0.622	59	0.607	65
Insufficient provision for ventilation	0.647	60	0.667	50	0.652	50	0.655	54
Defective of duct installation	0.729	41	0.717	42	0.713	34	0.720	37
Air condition/Heating system not cool enough and/or warm enough	0.647	60	0.700	47	0.704	39	0.684	49
Noisy, no air movement	0.776	24	0.733	36	0.583	63	0.697	44
Stoppage of supply	0.765	31	0.717	42	0.504	69	0.662	53
Poor cooling and/or heating system	0.706	46	0.714	45	0.652	50	0.691	46
Uneven distribution of phase	0.823	9	0.837	10	0.822	9	0.827	11
Inadequate Acoustic Insulation	0.776	24	0.813	20	0.790	13	0.793	15

4.5.2. Tests for Agreements on Types of Building Defect among Respondents

The purpose of a hypothesis test is to avoid being deceived by chance occurrences and to evaluate whether there is agreement of opinions among respondents or not. So one of the objectives of this thesis is to investigate whether there are agreements on the attitudes of stakeholders towards the types of defects in public building projects during DLP in Jimma Town or not. Accordingly, this

section presents the results of the correlation conducted by using Spearman rank correlation coefficients to identify the Correlation Coefficients of the participants in rankings of types of defects. They are Consultants vs. Clients, Consultants vs. Contractors, and Clients vs. Contractors on the different variables of building defect and their rate of occurrence. Therefore, the results are shown base on the Spearman's rank correlation coefficient, and p-values for testing significance in Table 4.12 below.

Table 4.12: summary of correlation test on the ranking of type of defects

Correlations					
Respondents			Consultants	Clients	Contractors
Spearman's rho	Consultants	Correlation Coefficient	1	**0.854****	**0.790****
		Sig. (2-tailed)	.	0.000	0.000
		N	71	71	71
	Clients	Correlation Coefficient	0.854**	1	**0.796****
		Sig. (2-tailed)	0.000	.	0.000
		N	71	71	71
	Contractors	Correlation Coefficient	0.790**	0.796**	1
		Sig. (2-tailed)	0.000	0.000	.
		N	71	71	71

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.12 presents the Spearman correlation coefficient for types of defect among the three respondents group which are: consultants, clients and contractors. For this correlation groups, the coefficient between consultants and clients equals to 0.854 with P-value (Sig.) = 0.000 The P-value is less than the level of significance, $\alpha = 0.01$, so there is a significant relationship between consultants and clients. The correlation coefficient between consultants and contractors equals to 0.790 with P-value (Sig.) = 0.000. The P-value is less than the level of significance, $\alpha = 0.01$, so there is a significant relationship between consultants and contractors. In addition, the correlation coefficient between client and contractor equals to 0.796 with P-value (Sig.) = 0.000. The P-valueless than the level of significance, $\alpha = 0.01$, so there is a significant relationship between clients and contractors. Therefore, it can be said that the degree of agreement among the three groups of respondents is significant regarding to types of defects on public building projects in Jimma town during DLP.

Overall Discussion on Types of Defects

As we have seen from table 4.11 the perception of consultants, clients and contractors the top ten types of defects which were identified after the defects analyzed by using Excel and SPSS v20 defects were ranked as shown in table 4.13 below. Hence, Leakage of roof has been leading ranked in the first position with RII=0.893 value by the consultants, clients and contractors. The second

frequent defect was Damp/leakages in ceilings with RII=0.856 value has been ranked by the consultants, clients in the second position and by contractors in the sixth positions. The third frequent defect was Peeling off paint with RII=0.848 value has been ranked by the consultants and clients in the third position and by the contractors in the fourth position. The forth frequent defect was Seepage from defective pipe works or sanitary fixture with RII=0.840 value has been ranked by the consultant and contractor in the third position and by the clients in the sixth position.

The 5th frequent defect was Short in circuit Breaker with RII=0.833 value has been ranked by the contractor in the second position, clients in the eight and by the consultant in the eleven position. The 6thfrequent defect was Plastering Cracks with RII=0.832 value has been ranked by the consultant and contractor in the fifth position and by the clients in the fourth position. The 7thfrequent defect was Broken or leaking sanitary fixtures with RII=0.830 value has been ranked by the consultant in the tenth position, by the clients in the fifth position and by the contractor in the eighth position. The 8thfrequent defect was Water seepage through windows with RII=0.829 value has been ranked by the consultant in the twelfth position, by the clients in the ninth position and by the contractor in the seventh position. The 9thfrequent defect was Handling damaged with RII=0.828 value has been ranked by the consultant and clients in the twelfth position and by the contractor in the ninth position. The 10thfrequent defects were Sanitary fitting damaged/broken and Uneven distribution of phase with RII=0.827 value has been ranked by the consultant in the eighth position, by the clients in the tenth position and by the contractor in the ninth position.

Table 4.13: Overall Responses between Consultants, Clients and Contractors for Types of defects

Type of Defects	Consultant		Clint		Contractor		Average Weight	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Leakage of roof	0.889	1	0.90	1	0.891	1	0.893	1
Damp/leakages in ceilings	0.859	2	0.88	2	0.826	6	0.856	2
Peeling off paint	0.850	3	0.86	3	0.828	4	0.848	3
Seepage from defective pipe works or sanitary fixture	0.850	3	0.84	6	0.830	3	0.840	4
Short circuit Breaker	0.822	11	0.83	8	0.838	2	0.833	5
Plastering Cracks	0.824	5	0.84	4	0.827	5	0.832	6
Broken or leaking sanitary fixtures	0.822	10	0.84	5	0.825	8	0.830	7
Water seepage through windows	0.822	12	0.83	9	0.826	7	0.829	8
Handling damaged	0.824	7	0.84	7	0.822	9	0.828	9
Sanitary fitting broken	0.823	8	0.83	10	0.822	9	0.827	10
Uneven distribution of phase	0.823	8	0.83	10	0.822	9	0.827	10

4.5.3. Types of defects categories

Table 4.14:- RII and ranks of types of defects categories

Types of defect	Degree of Impact		
	RII	RII %	Rank
Roof	0.809	80.85%	1
Ceiling	0.758	75.78%	2
Sanitary work	0.755	75.47%	3
Wall	0.746	74.60%	4
Toilet and Shower	0.732	73.21%	5
Door	0.709	70.90%	6
Mechanical work	0.708	70.77%	7
Electrical work	0.703	70.31%	8
Window	0.696	69.63%	9
Floor	0.685	68.51%	10
Glazing	0.643	64.25%	11

According to results in Table 4.14 types of defects categories of roof was ranked as the first group which has highest types of defects with RII 80.85%. Ceiling was ranked as the second group with RII 75.78% that defects on building construction. Sanitary work was ranked as the third group with RII 75.47%, which defects on building construction. A defect in wall was ranked as the fourth group with RII of 74.60% value defects on building project. Toilet and Shower was ranked as the fifth group with RII 73.21% value defects on building project.

4.6. Reliability Checking - Cronbach's Alpha

The reliability of the data was analyzed by using Statically Package for Social Sciences version 20 (SPSS v20). SPSS v20 was used to run the value of Cronbach's alpha and the results for Design, Construction, Material, Climatic condition, and Subsurface Related Causes of Defects characteristics are as shown below.

Causes of Defects which have Cronbach's coefficient alpha value of greater than 0.7 are considered as highly reliable and Cronbach's coefficient alpha value of between 0.3-0.7 is considered as moderately reliable.

Table 4.15: Cronbach's Alpha for questionnaires reliability checking

Independent Variables (Causes of defects)	**Number of Items (k)**	**average of the inter-item correlations (r)**	**Cronbach's Alpha value =** $\frac{(K*r)}{1+(k-1)r}$
Design Related Causes of Defects	7	0.74	**0.95**
Construction Related Causes of Defects	29	0.80	**0.99**
Material Related Causes of Defects	6	0.88	**0.98**
Climatic condition Related Causes of Defects	3	0.50	**0.75**
Subsurface Related Causes of Defects	5	0.87	**0.97**

As shown in the table 4.15, all questionnaires related to Design Related Causes of Defects, Construction Related Causes of Defects, Material Related Causes of Defects, Climatic condition Related Causes of Defects and Subsurface Related Causes of Defects characteristics are *highly reliable* because they had Cronbach's alpha value of greater than 0.7.

4.7. Ranking of Causes of Defects during Defect Liability Period in Public Building Construction Projects based on their Categories

The second objective of the study has been to identify causes of defects on the building constructions. Fifty (50) causes of defects those categorized in five sub division were identified from the literatures. The questionnaires were designed to identify the actual causes of defects in Building Construction in Jimma Town during DLP. The Responses of views regarding to the causes of defects have been identified through questionnaires collected. This question was asked in order to evaluate causes of defects in public buildings construction (See Anex-1 in section-2).

the five main causes of defects were design related causes of defects, Construction technical and management related causes of defects, material related causes of defects, climatic condition related causes of defects and Subsurface/ geotechnical related causes of defects in public buildings as mentioned by the questionnaires. The responses were analyzed using by the Microsoft Excel and SPSS software package. The analysis was divided in to three groups the consultants' point of view, the clients' point of view, and the contractors' point of view and a correlation test was done between the groups. A ranking system using the Relative Importance Index (RII) method was calculated to find the most significant factor.

4.7.1. Design Related Causes of Defects

Table 4.16 shows all design related causes of defects on building construction project in Jimma town. They are included in the questionnaire and ranked in accordance to their weight from the consultants, clients and contractors perspectives. The results from consultants showed that Faulty Design to be the first causes of defects with Score value RII = 0.76 value; Inaccurate specifications the second causes of defects with a score of with RII = 0.722 value. Furthermore, the third causes of defect ranked was Low quality of design standards with a score value RII = 0.692 value.

According to clients consideration, the result showed that Faulty Design was the first causes of defect with RII = 0.83 value; and Inaccurate specification was second causes of defects with RII = 0.77 value. Furthermore, the third causes of defects ranked was Poor detailing with RIIS = 0.72 value.

Likewise, results showed that contractors also reflected that Faulty Design was the first causes of defect with RII = 0.826 value; and Inaccurate specification was second causes of defect with RII = 0.783 value. Furthermore, the third causes of defects ranked was Low quality of design standards with RII= 0.67 value.

Table 4.16:- Relative Importance Index and Ranks for Design related causes of defects

Causes of Defects	Consultants		Clients		Contractors		Three Party		
	RII	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**Overall Rank**
Faulty Design	0.76	1	0.83	1	0.826	1	0.805	1	4
Inaccurate specification	0.722	2	0.77	2	0.783	2	0.758	2	19
Poor detailing	0.659	5	0.72	3	0.653	5	0.677	3	36
Low quality of design standards:	0.692	3	0.633	5	0.67	3	0.665	4	39
Low quality of materials standards	0.665	4	0.667	4	0.649	7	0.660	5	41
Location of building	0.59	6	0.583	6	0.662	4	0.612	6	44
Inadequate structural support roof truss	0.586	7	0.573	7	0.65	6	0.603	7	45

Overall, the three respondent groups suggested that Faulty Design was the top causes of defect with RII = 0.805 value; and Inaccurate specification was the second causes of defect with RII = 0.758 value. Furthermore, the third causes of defects ranked was Poor detailing with RII = 0.677 value, details of the other ranks are illustrated in table 4.16.

4.7.2. Construction Technical and Management Related Causes of Defects

Table 4.17 shows all construction management related causes of defects on building construction project in Jimma town. They were included in the questionnaire and ranked in accordance to their weight from the consultants, clients and contractors perspectives. Based on data results showed that in Jimma town building construction project consultants considered Poor Workmanship to be the first major factor affecting defects with a score of RII = 0.812 value; Poor project management is the second causes of defect with a score of RII = 0.81 value, and the third causes of defect ranked by the consultants respondents was Poor plumbing works with a score of RII = 0.777 value.

According to the clients Poor Workmanship to be the first major causes of defect with Score of RII = 0.867 value; and Poor project management was second causes of defects with a score of RII = 0.86 value. Furthermore, the third causes of defects ranked was Poor supervision of site workers with a score of RIIS = 0.823 value.

Likewise, the data from the contractors also revealed that Poor Workmanship to be the top significant causes of defect Score of with RII = 0.835 value; and Not follow the method statement given was second significant causes with a score of with RII = 0.809 value. Furthermore, the third causes of defects ranked was Poor supervision of site workers with a score of RIIS = 0.791 value.

Table 4.17:- Relative Importance Index and Ranks for construction technical and management related causes of defects

Causes of defects	Consultants		Clients		Contractors		Three Party		
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	Overall Rank
Not follow the method statement given	0.747	13	0.81	8	0.809	2	0.789	5	9
Improper Manpower allocation	0.724	17	0.583	27	0.7	21	0.669	25	38
Improper site condition survey	0.676	25	0.733	16	0.678	23	0.696	22	33
Non-compliance specifications	0.729	15	0.733	16	0.722	18	0.728	17	25
Failure to maintain properly	0.753	10	0.8	10	0.765	10	0.773	10	15
Improper installing elements	0.729	15	0.748	15	0.748	12	0.742	14	21
Lack of adequate skilled workers in the construction industry	0.763	8	0.693	23	0.783	4	0.746	13	20
Conflicting details on drawings	0.753	10	0.783	12	0.748	12	0.761	12	18

Improper methods of installation	0.765	6	0.817	4	0.748	12	0.776	9	14
Poor supervision of site workers	0.775	5	0.823	3	0.791	3	0.796	3	6
Improper construction joints	0.765	6	0.817	4	0.765	10	0.782	7	13
Poor plumbing works	0.777	3	0.801	9	0.77	9	0.782	7	11
Poor vibration	0.718	18	0.667	24	0.748	12	0.711	20	29
Lack of coordination of work	0.671	26	0.728	21	0.696	22	0.698	21	30
Lack of experience	0.741	14	0.8	10	0.774	7	0.772	11	16
Inaccurate measurements	0.706	20	0.783	12	0.591	27	0.694	23	35
Inadequate curing period	0.7	22	0.733	16	0.715	19	0.716	19	28
Inadequate protection work in the construction site.	0.749	12	0.733	16	0.737	17	0.74	15	22
Non implementation of corrective actions during the construction process	0.701	21	0.667	24	0.643	25	0.67	24	37
Poor project management	0.81	2	0.86	2	0.781	5	0.817	2	2
Poor Workmanship	0.812	1	0.867	1	0.835	1	0.838	1	1
Limited time for execution	0.6	29	0.725	22	0.661	24	0.662	26	40
Corruption	0.647	28	0.583	27	0.565	29	0.599	28	46
Work executed are not in proper manner	0.718	18	0.783	12	0.713	20	0.738	16	23
Issues with fund and cash flow	0.671	26	0.517	29	0.583	28	0.59	29	47
Inadequate communication	0.776	4	0.816	6	0.781	5	0.791	4	7
Lack of responsibility	0.761	9	0.813	7	0.774	7	0.783	6	11
Lack of systematic supervising	0.681	24	0.733	16	0.74	16	0.718	18	27
Ineffective planning and scheduling	0.694	23	0.6	26	0.617	26	0.637	27	42

Overall the respondent's consideration on the result shows Table 4.17. Poor Workmanship to be the top major causes of defect Score of with RII = 0.838 value; and Poor project management was second causes of defect with a score of with RII = 0.817 value. Furthermore, the third cause of defects ranked was Poor supervision of site workers with a score of RII = 0.796 value details of the other ranks are illustrated in table 4.18.

4.7.3. Material Related Causes of Defects

Table 4.18 shows all material related causes of defects on building construction project in Jimma town. Data from the questionnaire were ranked according to their weight of the consultants, clients

and contractors perspectives. The results shown in Table 4.19 revealed that Jimma Town building construction project consultants considered Defective construction material to be the highest major factor of defects with Score of RII = 0.781 value; and Poor material usage and not according to specification is the second significant factor with a score of RII = 0.776 value. Furthermore, the third causes of defect ranked by the consultants respondents was equipment not performing to specification with a score of RII = 0.714 value.

The clients' reflections are also listed in the same table 4.18. Accordingly, the result showed that Defective construction material to be the highest causes of defect with Score of RII = 0.85value; and Poor material usage and not according to specification was second significant causes with a score of RII = 0.833value. Furthermore, the third causes of defects ranked was Equipment not performing to specification with a score of RII = 0.767 value.

According to the *contractors*, Defective construction material to be the top significant causes of defect with Score of RII = 0.80 value; and Poor material usage and not according to specification was second significant causes with a score of RII = 0.758 value. Furthermore, the third causes of defects ranked was Limited cost with a score of RII = 0.742 value.

Table 4.18:- Relative Importance Index and Ranks for material related causes of defects

Causes of Defects	Consultant		Clint		Contractor		Three Party		
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	Overall Rank
Defective construction material	0.781	1	0.85	1	0.8	1	0.81	1	3
Poor material usage and not according to specification	0.776	2	0.833	2	0.758	2	0.789	2	8
Limited cost	0.659	4	0.758	4	0.742	3	0.72	3	26
Lack of the proper equipment	0.635	5	0.758	4	0.696	4	0.696	4	32
Equipment not performing to specification	0.714	3	0.767	3	0.609	5	0.696	4	31
damaged during transportation, loading and unloading	0.588	6	0.683	6	0.6	6	0.624	6	43

Overall the Consultants, Clients and Contractors respondent's consideration on the result show table 4.19. Defective construction material was the top major causes of defect with Score of RII = 0.81 value; and Poor material usage and not according to specification was second causes of defect with a score of RII = 0.789 value. Furthermore, the third cause of defects ranked was Limited cost with a score of RII = 0.72 value and details of the other ranks are illustrated in table 4.18.

4.7.4. Weather and Climatic Condition Related Causes of Defects

All climatic condition related causes of defects on building construction project in Jimma Town are illustrated in Table 4.19. The result shows that Jimma Town building construction project consultants considered that Weather and Climatic condition to be the top significant factor of defects with Score of RII = 0.772 value; and using materials unsuitable for the climatic conditions is the second significant factor with a score of RII = 0.635 value. Furthermore, the third causes of defect ranked was Surrounding temperature and environment with a score of RII = 0.612 value.

According to clients, Weather and Climatic condition has been the first major causes of defect with Score of RII = 0.827 value; and Surrounding temperature and environment was second significant causes with a score of RII = 0.75 value. Furthermore, the third causes of defects ranked was Using materials unsuitable for the climatic conditions with a score of RII = 0.70 value.

Data from the Contractors are reflected in table 4.22. Hence, the Weather and Climatic condition to be the first significant causes of defect with Score of RII = 0.79 value; and Surrounding temperature and environment was second significant causes with a score of RII = 0.722 value. Furthermore, the third causes of defects ranked was Using materials unsuitable for the climatic conditions with a score of RII = 0.696 value.

Overall the Consultants, Clients and Contractors respondent's consideration on the result show table 4.22. Weather and Climatic condition to be the top significant causes of defect with Score of RII = 0.769 value; and Surrounding temperature and environment was second significant causes with a score of with RII = 0.695 value. Furthermore, the third causes of defects ranked was Using materials unsuitable for the climatic conditions with a score of RII = 0.677 value.

Table 4.19:- Relative Importance Index and Ranks for climatic condition related causes of defects

Causes of Defects	Consultants		Clients		Contractor		Three Party		
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	Overall Rank
Weather and Climatic condition	0.772	1	0.827	1	0.79	1	0.796	1	5
Surrounding temperature and environment	0.612	3	0.75	2	0.722	2	0.695	2	34
Using materials unsuitable for the climatic conditions	0.635	2	0.7	3	0.696	3	0.677	3	49

Overall, the results from Consultants, Clients and Contractors respondents showed that Weather and Climatic condition was the first top significant cause of defects with Score value of RII = 0.769 value. Surrounding environment temperature was the second significant cause with a score value of

RII = 0.695 value, Moreover, the third cause of defects as ranked by the respondents was the use of unsuitable materials for the climatic conditions with a score value of RII = 0.677 value.

4.7.5. Subsurface Related Causes of Defects

Table 4.20 shows that Jimma Town building construction project consultants considered that Not properly compacted to be the first significant factor affecting defects with Score of RII = 0.77 value. Furthermore, Procedural errors for the climatic conditions is the second significant factor with a score of RII = 0.765 value; the third causes of defect ranked was Soil settlement with a score of RII = 0.753 value.

According to clients, Not properly compacted to be the first significant factor affecting defects with Score of RII = 0.80 value. Procedural errors for the climatic conditions is the second causes of defects with a score of with RII = 0.783 value; the third causes of defect ranked was Soil settlement with a score of with RII = 0.683 value.

By contractors reflection on the result shows table 4.24. Not properly compacted to be the top significant factor affecting defects Score of with RII = 0.788 value. Furthermore, Procedural errors for the climatic conditions is the second significant factor with a score of with RII = 0.765value; the third causes of defect ranked was Soil settlement with a score of with RII = 0.763 value.

Table 4.20:- Relative Importance Index and Ranks for subsurface related causes of defects

Causes of Defects	Consultant		Client		Contractor		Three Party		
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	Overall Rank
Not properly compacted	0.77	1	0.8	1	0.788	1	0.786	1	10
Procedural errors	0.765	2	0.783	2	0.763	3	0.77	2	17
Soil settlement	0.753	3	0.683	3	0.765	2	0.734	3	24
Poor site investigation	0.718	4	0.65	5	0.591	4	0.653	4	48
Inadequate drainage	0.715	5	0.667	4	0.574	5	0.652	5	50

Overall the responses of Consultants, Clients and Contractors indicated that not properly compacted was the first top significant cause of defects with a Score of (RII = 0.786). Procedural errors was the second significant cause with a score of (RII = 0.77). The third significant cause of defects ranked by the respondents was the Soil settlement with a score of (RII = 0.734) as illustrated in table 4.24 above.

4.7.6. Test for Agreement on the Major Causes of Defect among Respondents

The agreement of project participants was ranking Design, Construction Technical and Management, Material, Climatic Condition, and Subsurface related causes of defects. The rank for the causes of defect based on cumulative value for their relative importance index as identified by each party are listed in Table below. Finally, the results of the agreements in each category, consultants, clients and contractors, were tested by means of Spearman rank correlation coefficient and p-value for significance testing.

Table 4.21:- Correlation test of Design related causes of defects among group groups

Correlations					
			Consultants	Clients	Contractors
Spearman's rho	Consultants	Correlation Coefficient	1.000	0.857*	0.750
		Sig. (2-tailed)	.	.014	.052
		N	7	7	7
	Clients	Correlation Coefficient	.857*	1.000	0.607
		Sig. (2-tailed)	.014	.	.148
		N	7	7	7
	Contractors	Correlation Coefficient	0.750	.607	1.000
		Sig. (2-tailed)	.052	.148	.
		N	7	7	7

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.21 presents the spearman correlation coefficient for Design related causes of defects among the three respondents group such as consultant, client and contractor. For this correlation group, the coefficient between consultant and client equals to 0.857 with P-value (Sig.) = 0.014 The P-value is less than the level of significance, $\alpha = 0.05$, so there is a significant relationship between consultant and client. The correlation coefficient between consultant and contractor equals to 0.750 with P-value (Sig.) = 0.052. The P-value is less than the level of significance, $\alpha = 0.05$, so there is a significant relationship between consultant and contractor. In addition, the correlation coefficient between client and contractor equals to 0.607 with P-value (Sig.) = 0.148. The P-value is more than the level of significance, $\alpha=0.05$, so there is insignificant relationship between client and contractor. Therefore, it can be said that there is a significant degree of agreement among the respondents regarding to design related causes of defects on public building projects in Jimma town during DLP.

Table 4.22:- Correlation test of Construction Technical and Management related causes of defects among groups

Correlations					
			Consultants	Clients	Contractors
Spearman's rho	Consultants	Correlation Coefficient	1.000	.802**	.855**
		Sig. (2-tailed)	.	.000	.000
		N	29	29	29
	Clients	Correlation Coefficient	.802**	1.000	.756**
		Sig. (2-tailed)	.000	.	.000
		N	29	29	29
	Contractors	Correlation Coefficient	.855**	.756**	1.000
		Sig. (2-tailed)	.000	.000	.
		N	29	29	29

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.22 presents the spearman correlation coefficient for construction technical and management related causes of defects among the three respondents group such as consultant, client and contractor. For this correlation group, the coefficient between consultant and client equals to 0.802 with P-value (Sig.) = 0.000 The P-value is less than the level of significance, $\alpha = 0.01$, so there is a significant relationship between consultant and client. The correlation coefficient between consultant and contractor equals to 0.855 with P-value (Sig.) = 0.000. The P-value is less than the level of significance, $\alpha = 0.01$, so there is a significant relationship between consultant and contractor. In addition, the correlation coefficient between client and contractor equals to 0.756 with P-value (Sig.) = 0.000. The P-value is less than the level of significance, $\alpha = 0.01$, so there is a significant relationship between client and contractor. Therefore, it can be said that there is a significant degree of agreement among the respondents regarding to construction technical and management related causes of defects on public building projects in Jimma town.

Table 4.23:- Correlation test of Material related causes of defects among groups

Correlations					
			Consultants	Clients	Contractors
Spearman's rho	Consultants	Correlation Coefficient	1.000	.986**	.829*
		Sig. (2-tailed)	.	.000	.042
		N	6	6	6
	Clients	Correlation Coefficient	.986**	1.000	.812*
		Sig. (2-tailed)	.000	.	.050
		N	6	6	6
	Contractors	Correlation Coefficient	.829*	.812*	1.000
		Sig. (2-tailed)	.042	.050	.
		N	6	6	6
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

Table 4.23 presents the spearman correlation coefficient for material related causes among the three respondents group such as consultant, client and contractor. For this correlation group, the coefficient between consultant and client equals to 0.986 with P-value (Sig.) = 0.000 The P-value is less than the level of significance, α = 0.01, so there is a significant relationship between consultant and client. The correlation coefficient between consultant and contractor equals to 0.829 with P-value (Sig.) = 0.042. The P-value is less than the level of significance, α = 0.05, so there is a significant relationship between consultant and contractor. In addition, the correlation coefficient between client and contractor equals to 0.82 with P-value (Sig.) = 0.05. The P-value is equal the level of significance, α = 0.05, so there is a significant relationship between client and contractor. Therefore, it can be said that there is a significant degree of agreement among the respondents regarding to material related causes of defects on public building projects in Jimma town.

Table 4.24:- Correlation test of climatic condition related causes of defects among groups

Correlations					
			Consultants	Clients	Contractors
Spearman's rho	Consultants	Correlation Coefficient	1.000	.500	.500
		Sig. (2-tailed)	.	.667	.667
		N	3	3	3
	Clients	Correlation Coefficient	.500	1.000	1.000**
		Sig. (2-tailed)	.667	.	.
		N	3	3	3
	Contractors	Correlation Coefficient	.500	1.000**	1.000
		Sig. (2-tailed)	.667	.	.
		N	3	3	3

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.24 presents the spearman correlation coefficient for Climatic condition problem causes among the three respondents group such as consultant, client and contractor. For this correlation group, the coefficient between consultant and client equals to 0.500 with P-value (Sig.) = 0.667 The P-value is greater than the level of significance, α = 0.01, so there is insignificant relationship between consultant and client. The correlation coefficient between consultant and contractor equals to 0.500with P-value (Sig.) = 0.667. The P-value is less than the level of significance, α = 0.01, so there is insignificant relationship between consultant and contractor. In addition, the correlation coefficient between client and contractor equals to 0.500 with P-value (Sig.) = 0.01. The P-value is equal the level of significance, α = 0.01, so there is insignificant relationship between client and contractor. Therefore, it can be said that there is insignificant among the respondents regarding to Climatic condition related causes of defects on public building projects in Jimma town.

Table 4.25:- Correlation test of subsurface related causes of defects among groups

Correlations					
			Consultants	Clients	Contractors
Spearman's rho	Consultants	Correlation Coefficient	1.000	.900*	.900*
		Sig. (2-tailed)	.	.037	.037
		N	5	5	5
	Clients	Correlation Coefficient	.900*	1.000	.800
		Sig. (2-tailed)	.037	.	.104
		N	5	5	5
	Contractors	Correlation Coefficient	.900*	.800	1.000
		Sig. (2-tailed)	.037	.104	.
		N	5	5	5

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.25 presents the spearman correlation coefficient for Climatic condition problem causes among the three respondents group such as consultant, client and contractor. For this correlation group, the coefficient between consultant and client equals to 0.900 with P-value (Sig.) = 0.037 The P-value is less than the level of significance, $\alpha = 0.05$, so there is a significant relationship between consultant and client. The correlation coefficient between consultant and contractor equals to 0.900 with P-value (Sig.) = 0.037. The P-value is less than the level of significance, $\alpha = 0.05$, so there is a significant relationship between consultant and contractor. In addition, the correlation coefficient between client and contractor equals to 0.800 with P-value (Sig.) = 0.104. The P-value is more the level of significance, $\alpha = 0.05$, so there is a significant relationship between client and contractor. Therefore, it can be said that there is a significant among the respondents regarding to subsurface problem related causes of defects on public building projects in Jimma town.

4.7.7. Rank Summary of Causes of defects categories

Ranks of Causes of Defect can be summarized in the following five categories. Construction management and technical was ranked as the first group which has a top cause of defects with RII = 73.15%. The construction deficiencies occur by technical and managements that leads poor workmanship and poor project management. Material deficiencies were ranked as the second group with RII = 72.29% for its impact on building construction. Design related cause of defect was ranked as the third group with RII = 68.30% which affect the building construction. Climatic Condition related cause of defect was ranked as the fourth group with RII = 68.26% which influence on public building construction. Subsurface related cause of defect was ranked as the fifth group with RII = 67.90% value.

Table 4.26: RII and ranks of causes of defects categories

Causes of defect	Degree of Impact		
	RII	RII %	Rank
Construction technical and management-related causes of defects	0.73	73.15%	1
Material related causes of defects	0.72	72.29%	2
Design related causes of defects	0.68	68.30%	3
Climatic Condition related causes of defects	0.68	68.26%	4
Subsurface related causes of defects	0.68	67.90%	5

4.7.8. Summary of the Most Important Ten Causes of Defects during Defect Liability Period based on Overall Responses of the Respondents

Table 4.27 shows the most ten important causes of defects during defect liability period in building construction project in Jimma Town.

The top ten causes of defects combining the responses of all respondents which were identified after the causes of defect analyzed by using Excel and SPSS v20 defects were ranked as shown in table 4.26 below. The first top raked causes of defects by all respondents were Poor Workmanship with RII= 0.838 value. The second ranked cause was Poor project management with RII = 0.817 value. The third ranked cause was Defective construction material with RII=0.812 value. The forth ranked cause was Faulty Design with RII = 0.805 value. The fifth ranked cause was Weather and Climatic condition with RII =0.797 value. The 6^{th} ranked cause was Poor supervision of site workers with RII=0.796 value. The 7^{th} ranked cause was Inadequate communication with RII=0.791 value. The 8^{th} ranked cause was Poor material usage and not according to specification with RII=0.789 value.The 9^{th} ranked cause was Not follow the method statement given with RII=0.789 value. The 10^{th} ranked cause was Not properly compacted with RII=0.786 value.

Table 4.27:- overall responses between consultants, clients and contractors for causes of defects

Causes of defects	Consultant		Clint		Contractor		Average Weight	
	RII	Rank	RII	Rank	RII	Rank	RII	Overall Rank
Poor Workmanship	0.812	1	0.867	1	0.835	1	0.838	1
Poor project management	0.81	2	0.86	2	0.781	10	0.817	2
Defective construction material	0.781	3	0.85	3	0.80	4	0.812	3
Faulty Design	0.76	15	0.83	5	0.826	2	0.805	4
Weather and Climatic condition	0.772	8	0.827	6	0.79	6	0.797	5
Poor supervision of site workers	0.775	7	0.823	7	0.791	5	0.796	6
Inadequate communication	0.776	5	0.816	10	0.781	10	0.791	7
Poor material usage and not according to specification	0.776	5	0.833	4	0.758	19	0.789	8
Not follow the method statement given	0.747	20	0.81	12	0.809	3	0.789	9
Not properly compacted	0.77	9	0.8	14	0.788	7	0.786	10

4.8. Adequacy of the Percentage of the Retention payment

This section presents the analysis of the main objective question seeking opining from participants regarding the adequate of retention payments in public building construction projects. Data has been analyzed under three major groups i.e. contractors, consultants, and client. The results for using three major groups are described in the next.

Contractors View's

According to table 4.28 shown that contractor's the most common percentage retention payment held 5% of contract value as said by 56.52% of respondents. The second percentage retention payment of 3% of the contract value as stated by 26.09% of respondents, and the third percentage was cited 10% as said by 17.39% of respondents.

Consultants View's

Consultants' reflection the amount of retention payment held 10% of contract value as believed by 52.94% of respondents. The second most common rate was cited 5% of contract value as believed by 41.18% of respondents; and the third 5.88% of consultants mentioned retention payment of 3% of the contract value.

Client View's

As shown table 4.28 that as 58.33% of client respondents say that they hold a maximum retention payment of 10% of the contract value. The second rank was with 41.67% of client respondents hold a 5% of the contract value. None of the client respondents say they hold 3% of the contract value.

Table 4.28:- Rate of Retention payment from Interim Payment

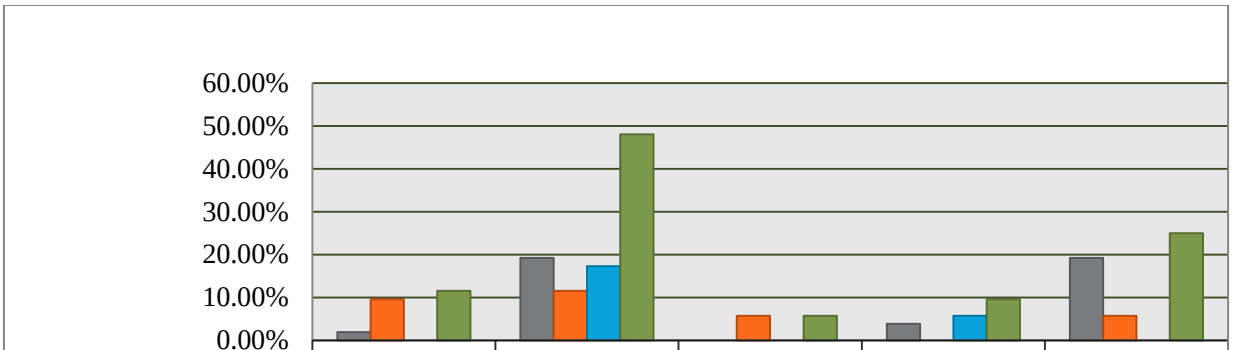
Percentage of Retention payment	Contractors	Consultants	Clients	Total Responses
Reduce, 3% the amount of retention payment	26.09%	5.88%	-	**13.46%**
Maintenance as it is**,** 5% the amount of retention payment	56.52%	41.18%	41.67%	**48.08%**
Increase, 10% the amount of retention payment	17.39%	52.94%	58.33%	**38.46%**

Overall responses

As Table 4.28 shown, Overall responses through experience contractor, consultants, and clients by (48.08%) of respondents the retention percentages of 5% are agreed. The second rank most common rate was mentioned with (38.46%) respondents where retentions are 5% decide. Furthermore, the third rank with (13.46%) a small number of respondents where retention payments are 3% of contract value.

4.8.1. The Contractors Will Not Motivated by the Half of Retention Payments to Rectify Defects

As figure 4.24 shown all respondents to the contractor, consultant and client surveys with if the currently used the half of 5% retention payment motivates the local and foreign contractors to rectify defects during defects liability period (DLP) or not. The majorities of the respondents' percentage with (48.08%) value agreed that half of 5% retention payment would not be sufficient and that it would not motivate both the local and foreign contractors to undertake correction works. The second percentages strongly disagree by means of (25%) value not sufficiently motivates local and foreign contractors to rectify the defects. The third percentages strongly agree by means of (11.54%) value not sufficiently motivates local and foreign contractors to rectify the defects, and also disagree with (9.62%) value not sufficiently motivates local and foreign contractors to correction the defects in time.



	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Contractor	1.92%	19.23%	0%	3.85%	19.23%
Consultant	9.62%	11.54%	5.77%	0%	5.77%
Client	0.00%	17.31%		5.77%	
Total Responses	11.54%	48.08%	5.77%	9.62%	25%

Figure 4.24:- half of retention payments not motivate the contractor during DLP

4.8.2. An Analysis of the Purpose of Retention Payment

Table 4.29 show that (56.52%) of the contractors responded to this survey question that the intended purpose of retention payments is to safeguard the employer to make corrections on defective works that the contractor fails to do as the other contractor respondents (39.13%) consider that retention payment is used to bind the contractors not to quit, and also (4.35%) of the contractor respondents think that it is to motivate contractors to undertake corrections and remedies for defective works at completion of works during defect liability period.

On the other hand, (70.59%) of the consultant suggested that the aim of keeping retention money is to motivate contractors to undertake corrections and remedies for defective works at completion of works during defect liability period. (23.53%) of the consultant supposes that retention payment is to safeguard the employer to make corrections on defective works that the contractor fails to do, and (5.88%) of the consultant respondents believe that retention payment is used as a binding system so that contractors will not quit.

Similarly, (50%) of clients responded that retention payment is kept to safeguard for the employer to make corrections on defective works that the contractor fails to do; (41.67%) of the client respondents suppose retention payment as safeguard money for the employer to make corrections on defective works that the contractor fails to do, and (8.33%) the client respondents believe that retention payment use as a binding system so that contractors will not quit.

Table 4.29:- Aims of Retention payment

The Aims of Collecting the Retention Payment	Contractors	Consultants	Clients	Total Responses
To use as safeguard money for the employer to make corrections on defective works that the contractor fails to do	56.52%	23.53%	50%	38.46%
To use as a binding system so that contractors will not quit	39.13%	5.88%	8.33%	25%
To motivate contractors to undertake corrections and remedies for detective works taken as remarks at completion of works during defects liability periods	4.35%	70.59%	41.67 %	36.54%

Finally, Those respondents to the contractor, consultant and client surveys with experience of holding retention payment used believe that by (38.46%) respondents retention payment will as safeguard money for the employer to make corrections on defective works that the contractor fails to do. (36.54%) say that retention payment will motivate contractors to undertake corrections and remedies for defective works at completion of works during defect liability period; and also (25%) respondents consider will use as a binding system so that contractors will not quit.

4.8.3. Causes for not Released Retention Payment by Clients for Contractors

All 23 participants belonging to the contractor group answered the question. Accordingly, causes for not paying retention payment by clients for contractors ranked the first as (43.47%) said that Dispute arose with contractor relating to defects, the second (30.43%) of respondents said the Contractor did not return to correct defects, the (17.39%) of the contractors suggested that Contractor's become insolvent, and of 8.7% of them said Contractors initially asked for the money, but did not pursue it. As shown in table 4.30.

The 17 respondents in the consultant group suggested the causes for clients not to pay retention payment for contractor as follows. Hence, (47.06%) of the consultants stated that the Contractor did not return to correct defects; the (23.53%) of them said the Dispute arose with contractor relating to defects and the other 23.53% reflected that Contractor's become insolvent, and the (8.33%) said Contractor initially asked for the money, but did not pursue it as shown in table 4.30.

The 12 client group respondents suggested the following about the causes for not paying retention payment. Thus, (41.66%) of the clients said that it was because the Contractor did not return to correct defects, the (25%)of respondents said Dispute arose with contractor relating to defects, and the other (25%) reflected that it was because the Contractor's become insolvent. (8.33%) of them

said that Contractors initially asked for the money, but did not pursue it. The details are shown in figure 4.25.

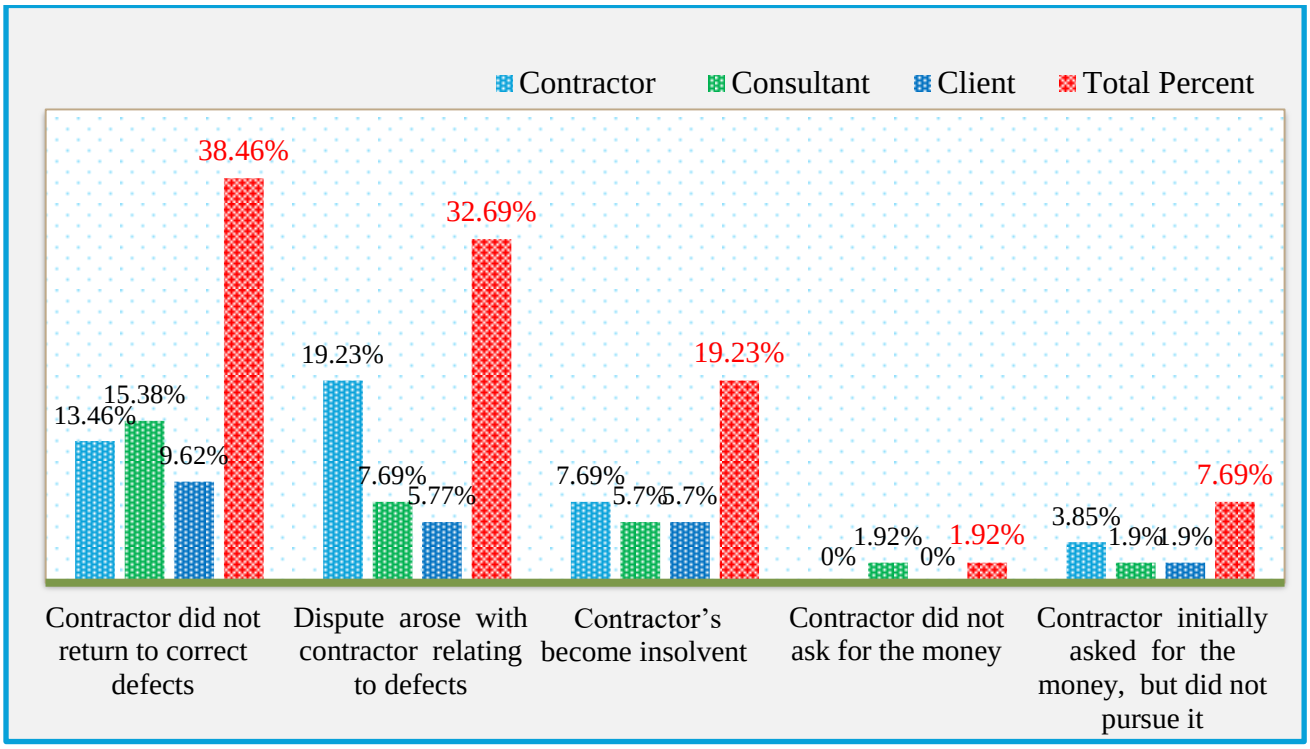


Figure 4. 25: Reasons for not paying Retention payment

Overall Responses

Responses of all respondents (contractor, consultant, and clients) were computed in percent's to obtain the major cause for not paying the retention payments. Thus, the result showed that (38.46%) of them said that the Contractor did not return to correct defects, and (32.69%) of them stated that dispute arose with a contractor relating with defects. The (19.23%) of the respondents indicated that Contractor's become insolvent, and (7.69%) of them showed that Contractor initially asked for the money, but did not pursue it, and finally, the (1.92%) of the respondents suggested, Contractor did not ask for the money as shown in figure 4.30.

From the above analytical results on reasons given by contractors, consultants, and clients the researcher infers that there are various reasons that the clients do not give the retention payments for the contractors. They were ranked as:

- Contractor did not return to correct defects". And the others were "
- Dispute arose with a contractor relating with defects;
- Contractor's become insolvent;
- Contractor initially asked for the money, but did not pursue it, and finally,
- Contractor did not ask for the money; as shown in the aforementioned discussions and Figure 4.25.

4.9. Semi-Structure Interview

This section offered the results of the semi-structured interviews conducted with representatives of experts from the contractor, consultant and clients in the public building construction in Jimma town. Seven semi-structured guiding questions were employed to identify varied views of the respondents as per the research purpose. Thus, three clients, seven consultants, and three contractors participated as interviewees'. Thus their replies are stated in this section. (The whole of the guiding interview questions are included in annex-2).

4.9.1. Responses about Types of Defects Occurring during Defect Liability Period in Public Buildings

The first item requested regarding the type of defects in public buildings in Jimma Town that happed during DLP. Hence the 3 client interviewees mentioned that most of the time sanitary and electrical works defects occurred in public building projects. They specifically pointed out that the electrical: disconnection, missing electrical fitting, misuse of electrical standard (code), electrical short circuit breaker and electro-mechanical defects. They added that sanitary, improperly installed and roof leakages are serious problems of the projects.

The consultant interviewees mentioned that: defective sanitary fixtures, cracking in-wall plastering and leakage in roof, cracking in different parts, irregular floor tiles, and irregular ceiling joint as well as sanitary joint problem were the mostly occurred defects. Besides, leakage on wastewater systems, defective key locker, unfitting doors and windows, cracked finished wall surfaces, installation work and rainwater leakage and waterproofing, electrical and mechanical works are the most common type of defects.

Lastly, the contractors interviewees mentioned that the common defects occurred were: the floor finish, sanitary and electrical works, Finishing work plastering and wall cracking, sanitary works, and electrical works and mechanical installation failures. Hence, results about types of defects obtained from the three groups of interviewees were the same as that of the results from the questionnaires.

4.9.2. Responses on Causes of Defects during Defect Liability Period in Public Buildings

This section describes the replies of the three groups of interviewees on causes of defects in public buildings in Jimma town during DLP. Three client interviewees mentioned that: poor or unskilled workmanship during the construction stage, use of substandard materials, and use of low-quality/standard material, lucks of building administration, poor project management and improper installation of sanitary were the commonly observed causes of defects.

The seven consultant interviewees mentioned that: poor material quality, poor construction methodology, design problem, poor communication and technical defects were the most common causes of defects. Besides, poor knowledge and skills, poor workmanship during execution, poor quality of materials, poor methods of construction, finishing materials (procedure), poor quality material utilization e.g. door handle, and poor utilization e.g. doors broken wings, and inadequate site supervision. Lastly, the three contractors' interviewees indicated that: Lack of skilled workmanship during construction and improper usage of different items after construction, lack of systematic supervising, and defective materials were the causes. In general, the respondents pointed out that design, workmanship, supervisory, management communication and use low-quality or standard materials were the most commonly observed causes of public building construction projects.

4.9.3. Responses on Consequences to the Public Building If No Action Is Taken Against the Defects during DLP

This question was asked to identify the consequences to the public building if no action is taken against the defects during defect liability period. Two of the interviewees responded that the problem with leakage and cracks affected the functionality of the building and it would be highly damaged and structurally transferred. On the other hand, five of the interviewees responded that the owner could not properly use the buildings if they are not rectified by the contractors because the damaged public buildings would be dangerous for the community to lives. They strengthen that the defective buildings would not give proper service, and they would lack their expected values. Others indicated that there might be deterioration and the buildings would not be functional. Lastly, two of the respondents suggested that nothing bad would happen, but the contractors would rectify the defects and the buildings would provide the expected services.

4.9.4. Responses on Precautions to Decrease the Defects in Public Building during DLP

The interviewees were requested what they perceive about defect reductions means. Hence, they perceived nine different types of precautions to reduce defects in public buildings during. The interviewees replied that nine precautions would be the remedial measures. Accordingly the remedial were: good construction manager, bid of (agreement) legal agreement before doing all things, the use of quality standard materials, the use of good workmanship during construction stage, continuous supervision, correct drawing and specification, use of accurate measurements, strict supervision, hard follow up and avoidance of corrupted persons (not come to work).

All of the 3 interviewee groups agreed that the contractor must rectify the defects in deferent part of the work according to the agreed statements (between the owner and the contractor). It needs immediate action to rectifying the defects after provisional acceptance; check in detail work items

during provisional acceptance and strict follow up and supervision during construction stage. One interviewee said that the contractors should mind their responsibility that they should do the appropriate quality work. In addition, two interviewees agreed that defects can be reduced by giving proper training to the workers and, by the contractor's follow up of the project, and checkup whether skilled persons are operating the most sensitive element or not.

4.9.5. Responses on Possibility of Achieving Zero Defects during Defect Liability Period

The interviewees were requested if zero defect was possible on public building constructions or not. The replies revealed that twelve of the interviewees responded that it is possible to minimize or reduce defects; however, it may not be easy to achieve zero defects in human involving projects; because of sophisticated nature of construction there are always imperfections so it is not possible to be ever perfect. On the other hand, three interviewees responded that it is possible to achieve zero defects by the use of good quality material standard and strong supervision during construction stage and during defect liability period and soon, constructing the building project according to the specification with adequate supervision and quality controlling as well as employing outstanding bidder for construction and consulting that will reduce the defects.

4.9.6. Responses on the effect of owner due to the Contractor Delay to Rectify the Defects over 12 Months

Retention payment stay with the owner for a long time due to the contractor delay to rectify the defects over 12 months. Do you think that situation affect the owner? How?

The client, consultant and contractor respondents were asked if they think that the delay of rectification of the defect over twelve months affects the owner. Eight of the interviewees said yes, it affects the owner/claims. Five of them responded No, it does not affect the owner because the retention payment is already that of the contractor so; the owners would not be affected due to the delay of the rectification since the delayed money safeguards the project. However, if the contactors correct defects in time, it obviously benefits both the owner and the contractors without any hesitations.

4.10. Discussion of Findings

This study was mainly intended to investigate reasons for contentious endings between public building contractors and owners in relation to defects with the retention payments that delayed the close-out of the projects in Jimma Town Constructions, during the defect liability period. Hence, to achieve this, the researcher proposed three specific objectives to identify the types and causes of defects as well as the adequacy of the retention payment to rectify the defects. This designed the appropriate methodologies. Accordingly, the study employed a mixed research approach and a descriptive survey design. It made uses of the purposive sampling techniques and four data-gathering instruments. They were desk study, observation, questionnaire, and interviews. The researcher further reviewed the related literature to fulfill the empirical and theoretical backup for the study. Hence, Distributed structured questionnaires to Fifty-eight personnel in the offices of contractors, consultants, and clients to obtain the desired data for analysis. Fifty-two questionnaires representing a response rate of 89.65% were returned and analyzed using descriptive and inferential statistics with the help of Excel and statistical package for social sciences (SPSS).

4.10.1. Type of defects in Public Building Projects during defect liability period

From the questionnaires, the interview and site observation, the common type of defects on public building projects were Leakages of roof, peeling off paint, and Damp/leakages in ceilings, these results from frequent defects. The types of defects were ranked in ascending defects and the most frequent were identified.

As ranked on questionnaires response previously in Table 4.11 it is clear that the first most types of defects were Leakage of roof, Damp/leakages in ceilings, peeling off paint, Short circuit Breaker and Seepage from defective pipe works or sanitary fixture.

The first major type of defects was Leakage of roof. This could also be defects due to the poor workmanship. Leakage of roof is actually one of the most types of defects and this fact is supported by the interviewees and the observations in the site. This similarly confirms with the literature review that Leakage of roof was one of the major types of defects. As Bedru, (2015) identified Leakage of roof was one of the major types of defects. The works of Elhag T & Boussabaine (1999) also listed that Leakage of roof was one of the most types of defects.

Damp/leakages in ceilings were the second major types of defects. Leakages in ceilings defects that usually happen on the ceiling of the building, the ceiling is damp or leaking defects due to poor workmanship.

The third major types of defects were peeling off paint, which is due to seepage of water by the poor workmanship. Peeling of painting usually shown on public building construction during defect liability period mainly on plastered wall, slab, columns and other areas which are exposed to excessive rain and great dampness same building that are located in Jimma town.

Short in circuit Breaker was the fourth major type of defect which is the result of the poor workmanship and design faulty. A short circuit breaker is happened by in case to use without a standard the power cable hot happens and the second case neutral wire (line) activates by power because of losing.

The fifth major type of defect was Seepage from defective pipe works or sanitary fixtures. Mostly this defect is attributed to poor workmanship, poor installation of sanitary fixtures. Due to this problem, Water seeps through a broken or defective pipe into the floor.

4.10.2. Causes of Defects in Public Building Projects during Defect Liability Period

To summarize causes of defects to findings described and discussed as ranked on questionnaires response previously in Table 4.27 reflects the list of causes of defects that were relevant for Jimma town in public building projects according to their causes of defects presented in their average and relative importance index. From this list the top five major causes of defects according to their rank order based on relative importance index were the following:

The first major cause of defects was *Poor Workmanship problem*, which lead to building defects and failures problems. Poor workmanship can deteriorate the building quality and performance, such as poor installation methods, poor mixing of materials, poor handling of materials, and poor planning. This causes of construction defects in public buildings in Jimma town during the construction stage and during DLP indications the inability of the employee to perform the required responsibility properly. This problem usually arises from a lack of proper skill, carelessness, and the absence of proper supervision at the workplace.

The second major cause of defects was *Poor project management*, that cause of construction defects during the construction stage and defect liability period in the construction industry. Proper construction management would enhance the workmanship quality in construction, and the delivery of building materials in accordance with specifications and the quality desired by the contractor is achieved through adequate supervision and executing proper quality management. So, Good construction management is very important for every building construction project in Jimma town.

Defective construction materials the third major cause of defects, that have a negative result on the serviceability of buildings in all-purpose during DLP and after DLP in public buildings construction

in Jimma town. Material deficiencies occur while low-quality materials are used during the construction stage and during Defect Liability Period. This problem arises due to a lack of supervision at the site and failure of the contractor to perform the required material testing prior to using for the construction purpose. The uses of these defective materials can consequence significant problems, such as failure to perform, and function adequately.

The fourth cause of defects was *Faulty Design* that causes can basis on the design error or design omission which when it happens have a much severe consequence. Poor design is the main reason for performance failure. It is the design failure that caused by the design professionals. This is because they have failed to prepare an accurate and complete set of drawings and also the construction documents. Design omission in buildings arises when a building is inadequately planned and built in a method that eventually leads to an architect's problems.

The fifth causes of defect was Weather and Climatic condition it is necessary to consider the weather climatic conditions in building construction industry and the effect to building materials in Jimma town. This means that buildings in the Jimma town tend to weather climatic condition rapidly change, mostly in respect to external building materials which are exposed to external causes such as rainfall, wind, solar radiation including, peeling off paint and defective plastered rendering, with this factor Weather related defects were caused by Heat from the sun, Moisture from the rain, Humidity in the air, and Wind loads.

The interviewees also reflected that poor: design, workmanship, supervisory, management, communication and use of low-quality/standard materials were the most commonly observed causes of defects in public building construction projects.

The above 1-5 lists were major causes of defects in Jimma town public building construction projects which were identified from this study according to their respondents and observed.

4.10.3. Finding Adequacy Percentage of Retention Payment during DLP

This section presents the analysis of the third objective the adequate retention payments in public building construction projects.

According to, the consultant, client, and contractor respondents, the top significance percentage of retention payment were accepted as shown in Table 4.18. Hence, 48.08% of the respondents suggested that 5% percentage of retention payment would be adequate to rectify defects of all types on the buildings during the defect liability period. Likewise, Kasiem, 2008 page 83 depicts that 5% performance bond in addition to the remaining half of the retention money which the employer withheld until the maintenance certificate is issued and it is safe for the employer. Furthermore, the contractor is obliged by law and by subsequent blacklisting for failing to correct defects as the

contractor has a legal obligation to rectify defects and most domestic contractors rectify defects for their goodwill than the collection of the remaining retention money.

Secondly, 38.46% of the consultants and clients respondents indicated that 10% retention payment would be the second adequate, while the contractors level it third. The retention payment should be increased to ten percent as per MoWUD Standard Conditions of Contract December, 1994Clause 60 (2), and new PPA (August 2011) clause 61 sub-clause 61.1. The consultant's, client and same contractor's reasons,

Nine consultants suggested that

- Sometimes the contractor cannot properly work remedial or defective works, because the cost increased from remedial works is bigger than 5% retention of the contract value.
- most of the time the contractors for building projects have defect is inefficient to correct the problem during Defect Liability Period
- 10% of the project cost is almost half of estimated project profit cost that means the contractor shall pay adequate attention to the project during construction progress than Defect Liability Period or maintenance phase (for local contractors are the best holding).

Seven clients suggested that

- For increasing retention payment the contractor actively motivates to maintaining the defects properly on time.
- It would motivate the contractor to rectify the defects and claim for the money in time.
- To increase the interest to rectify defects after completion of the project.
- To reduce the number of defects during the period of provisional and the contractor will not remain with remark during DLP.

Four contractors suggested that

- 5% of contract value is not enough to rectify the whole structural and finishing problems that happened in the building construction.
- If the amount of retention payment will be increased the contractor will be more interested to correct the defects otherwise; he will be replaced by somebody else to handle the construction defects by the retention payment.

According to Shunet, (2008) not support the retention percentage is normally 5 to 10 %. However, to provide the client with additional security, this figure can be as high as 10% but the effect of a higher retention percentage affects the contractor's cash How and increases tender figures as its cost form apart of all tender figures.

The third percentage of retention payment of 3% is said by (13.46%) of respondents have been agreed by the contractors in the second position, by the consultants in the third positions but none of the client respondents say they hold 3% of the contract value.

Six contractors have suggested that

- It would be better if the retention can be reduced to 3%. because this will be useful to the contractor to execute items using the retention payment and equivalent bank guarantee can be dealt with between client and contractor so,
- the retention payment it may be 3% reduction from the contractor payment agree

One consultant suggested that

- It would be better the retention payment is 3% to reduce from 5% because they maintain fewer and fewer defects.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. CONCLUSION

Triangulating all the results from the desk study, questionnaire, observation and interview the study sum up that the most affecting types of defects were Leakage of the roof, Damp/leakages in ceilings, Peeling off paint; Water seepage through windows, Sanitary fitting damaged/broken, Broken Glazing, Defective wastewater drainage system, Short Circuit Breaker and Unbalanced Power Distribution of phase. Besides, the causes of the occurrence of these defects were Poor workmanship, defective construction material, unrecognizing the weather or climatic condition and poor compactions. Thus, improper construction management, uneven measurement, use of low-quality materials standards and poor workmanship end with more defective results. Finally, the study reflected that the half of retention payment during defect liability period was also not motivating the contractors' to rectify the defects in Jimma building construction projects. Hence, the majority of the contractors, consultants, and clients agreed that the most common percentage of retention payment should be 5% to rectify defects of all types on the buildings during the defect liability period.

5.2. RECOMMENDATIONS

Hence, to solve the contentious ending between the contractors and the clients of building construction projects in Jimma Town, the study recommended that the following remedial measures should be facilitated in advance. Both the owners and the contractors should bear in mind that:

- Majority of construction defects happened owing to *Poor workmanship* causes of defect occurred by technical and poor project management. So, it would be important to train employees on quality building relater procedures and quality management because the workers and contractors would improve the quality of the works. Therefore, construction defects would be reduced.
- In addition, the contractors should ensure that the subcontractor are qualified, certified and have occupational licensing before agreeing for any works.
- As much as possible, the contractor should attempt to employ effective, efficient, and skilled manpower, while constructing the building phases, during Electric installations, Mechanical works, Sanitary works, Finishing works and other construction connected works. If there is a lack of skilled persons it would be better to train rather than missing the whole work, (they should provide a sort of team skills training).
- Quality management implementation by the contractor of a comprehensive quality control program is very critical during construction stages and during Defect Liability Period.

- The contractors have the responsibility to ensure the quality material as per the specification before delivery in-site and consultants shall approve each material type before installed. This can reduce the occurrence of construction defects caused by defective materials.
- There should be strict supervision and follow up to ensure the use of the appropriate: material quality standards, standard measures and rates, the proper procedural process of the various stages, as well as individuals' works in the successive construction stages.
- All stakeholders of construction projects should communicate adequately: before agreements, during the construction stage and in defect liability period, which would eliminate construction defects and design errors or omissions in designs. This would help in reducing gaps between them.
- During the provisional acceptance, the clients ensure half of the 5% retention payment enough for remaining works to be completed and to fit for the make corrections on defective works and the contractors are must be rectified the defects during the Defect liability period in one year.

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ANNEX-1: Questionnaire

This questionnaire is aimed at gathering data on **Investigation of Defects during Defect Liability Period in Public Building Construction Project in Jimma Town**. The study is purely for research purpose. So, your genuine and timely response is appreciated for success of the study. Therefore, I kindly ask you to respond to each items of the question very carefully.

General Instructions

- There is no need of writing your name
- Please put a tick (√) marks in the appropriate box of your answer Contact Address:

If you have any questions please contact me and I am available as per your convenience @Mobile: 09-39-90-51-01 or e-mail: **enquegg12@Gmail.com**

Thank you in advance for sacrificing your time to fill this questionnaire!

Section One: Respondent Profile

1. Which organization are you working currently?
   - Client
   - Contractor
   - Consultant
2. If your answer for question #1 is **Contractor** please mention grade of your company?

   _____
3. If your answer for question #1 is **Contractor**, in which type of contract our company engaged for in the construction?
   - Local contractor
   - Foreign contractor
4. What is your job position in your organization (optional)?

   _____
5. Educational Background
   - Graduate (MSC) Undergraduate (BSC)
   - Diploma, If other, please specify_____
6. Work Years of experience in the construction industry

   < 5 year's 5-10 year

   10-15 year's 15-20 years

If other, please specify_____

Section Two: Types of building Defects during defect liability period

Lists of types of building defects during defect liability period in building construction are mentioned below. From your experience, please tick the appropriate cell by indicating how much you agree to listed types of building defects during defect liability period in commercial buildings.

Agreement:

1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

No	Type of defects during defect liability period	Level of Agreement				
		1	2	3	4	5
1	**Floor**					
	▪ Uneven or irregular floor finishes					
	▪ Seepage from defective pipeworks or sanitary fixture					
	▪ Broken floor tiles					
	▪ Defective skirting					
	▪ Dampness in floors					
	▪ Crack floor					
	▪ Detached floor finishes					
	▪ Floor finishes not closely					
2	**WALL**					
	▪ Water penetration through external wall defects such as cracks and joints					
	▪ Wall Cracks					
	▪ Plastering Cracks					
	▪ Wall surface rough					
	▪ Peeling off paint					
	▪ Broken wall ceramic tiles					
	▪ Detached of ceramic wall tiles					
3	**Ceiling**					
	▪ Broken ceiling					
	▪ Damp/leakages in ceilings					
	▪ Uneven ceiling					
	▪ Ceiling and wall joint separation					
	▪ Peeling of point					
	Door					
	▪ Water seepage through doors					
	▪ Damaged door leaf					
	▪ Door not tight closed					
	▪ Door too tight					
	▪ Door frame tilt/damaged					

	▪ Handling damaged					
	▪ Key damaged					
5	**Window**					
	▪ Water seepage through windows					
	▪ Window not close					
	▪ Tight window					
	▪ Rubber on window ripped					
	▪ Window frame tilt/damaged					
	▪ Window lock damaged/malfunctioning					
6	**Roof**					
	▪ Leakage of roof					
	▪ Roof tiles tear off					
	▪ Broken/Damage skylight					
	▪ Damage or deterioration waterproofing membranes					
7	**Toilet and shower**					
	▪ Toilet/sink clogged					
	▪ Toilet pump damaged					
	▪ Shower tap damaged					
	▪ Leaky pipes					
	▪ Sanitary fitting damaged/broken					
	▪ Floor trap clogged					
	▪ Clogged water closet					
8	**Glazing**					
	▪ Brocken Glazing					
	▪ Improper fillings putty/stucco					
9	**Sanitary work**					
	▪ Insufficient water pressure or flows					
	▪ defective pipe joints or valves					
	▪ Leaking downpipe					
	▪ Defective wastewater drainage system					
	▪ Broken or leaking sanitary fixtures					
	▪ Blocked drains system					
	▪ Pump failure					
10	**Electrical Work**					
	▪ Electrical switches or outlets not working					
	▪ Lift failure/stoppage, unstable lifting					
	▪ Loose junction boxes for switches or convenience outlets					
	▪ Poor sound system installation					
	▪ Insufficient fire prevention or protection mechanism					

	▪ Fire alarm not working					
	▪ Electric sparks or shocks, electrocution					
	▪ Short circuit Breaker					
11	**Mechanical Work**					
	▪ Not cool enough, not warm enough					
	▪ Engines sound normal but no air movement					
	▪ Insufficient provision for ventilation					
	▪ Defective of duct installation					
	▪ Air condition/Heating system not cool enough and/or warm enough					
	▪ Noisy, no air movement					
	▪ Stoppage of supply					
	▪ Poor cooling and/or heating system					
	▪ Uneven distribution of phase					
	▪ Inadequate Acoustic Insulation					

Please specify if there are any other types of building defects during DLP in public building construction project._____

_____

Section Three: Causes of building Defects during defect liability period

Lists of causes of building defects during defect liability period in building construction are mentioned below. From your experience, please tick the appropriate cell by indicating how much you agree to listed causes of building defects during defect liability period in commercial buildings.

Agreement:

1.Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

No	**Causes of defect during Defect Liability Period**	**Level of Agreement**				
		1	**2**	**3**	**4**	**5**
1	**Design deficiencies**					
	▪ Faulty Design					
	▪ Inaccurate specification					
	▪ Low quality of materials standards:					
	▪ Poor detailing					
	▪ Low quality of design standards:					
	▪ Location of building					
	▪ Inadequate structural support roof truss					
	Construction Deficiencies					
	2.1 Causes of defects occurs by technical					
	▪ Not follow the method statement given					
	▪ Improper Manpower allocation					

	▪ Improper site condition survey					
	▪ Non-compliance specifications					
	▪ Failure to maintain properly					
	▪ Improper installing elements					
	▪ Lack of adequate skilled workers in the construction industry					
	▪ Conflicting details on drawings					
	▪ Improper methods of installation					
	▪ Poor supervision of site workers					
	▪ Improper construction joints					
	▪ Poor plumbing works					
	▪ Poor vibration					
	▪ Lack of coordination of work					
	▪ Lack of experience					
	▪ Inaccurate measurements					
	▪ Inadequate curing period					
	▪ Inadequate protection work in the construction site.					
	▪ Non implementation of corrective actions during the construction process					
	2.2 Causes of defects occurs by Management					
	▪ Poor project management					
	▪ Poor Workmanship					
	▪ Limited time for execution					
	▪ Corruption					
	▪ Work executed are not in proper manner					
	▪ Issues with fund and cash flow					
	▪ Inadequate communication					
	▪ Lack of responsibility					
	▪ Lack of systematic supervising					
	▪ Ineffective planning and scheduling					
3	**Material deficiencies**					
	▪ Defective construction material					
	▪ Poor material usage and not according to specification					
	▪ Limited cost					
	▪ Lack of the proper equipment					
	▪ Equipment not performing to specification					
	▪ damaged during transportation, loading and unloading					
4	**Climatic Condition**					
	▪ Weather and Climatic condition					
	▪ Using materials unsuitable for the					

	climatic conditions					
	▪ Surrounding temperature and environment					
5	**Subsurface deficiencies**					
	▪ Not properly compacted					
	▪ Procedural errors					
	▪ Soil settlement					
	▪ Poor site investigation					
	▪ Inadequate drainage					

Please specify if there are any other causes of building defects during DLP in public building construction project.

_____

_____

_____

Section Four-the amount Retention payment during defect liability period

1. The minimum net amount of retention payment to be paid is generally 5% of the project cost, which is reduced to 5% from 10% in MoWUD,Dec. 1994 conditions of contract. In your opinion, does this limit be maintained as it is or be varied considering the financial capacity of Local and Foreign contractors?

- ☐ Maintained as it is, 5%
- ☐ **Increased,** to 10 %
- ☐ **Reduced,** to 3 %

2. If you are answer question # 2 (**Increased/Reduced**) what is your reason?

_____

_____

_____

3. Most of the time this percentage of retention typically 5% (half of retention 2.5% during Defects Liability Period) of contract value, will not motivate contractors to undertake remedial works. What is your view of this statement?

- ☐ strongly agree
- ☐ Agree
- ☐ Neutral
- ☐ strongly disagree
- ☐ Disagree

4. A certain percentage of retention money is to be collected from the contractors certified payment. What do you think is the reason?

- ☐ to use as a safeguard money for the employer to make corrections on defective works that the contractor fails to do

- to use as a binding system so that contractors will not quit
- to motivate contractors to undertake corrections and remedies for detective works taken as remarks at completion of works during maintenance (defects liability) periods
- Others, specify_____

5. What are the reasons for not having paid back these retention payments at the end of the Defect Liability Period?

- Contractor did not return to correct defects
- Dispute arose with contractor relating to defects
- Contractor's become insolvent
- Contractor did not ask for the money
- Contractor initially asked for the money, but did not pursue it

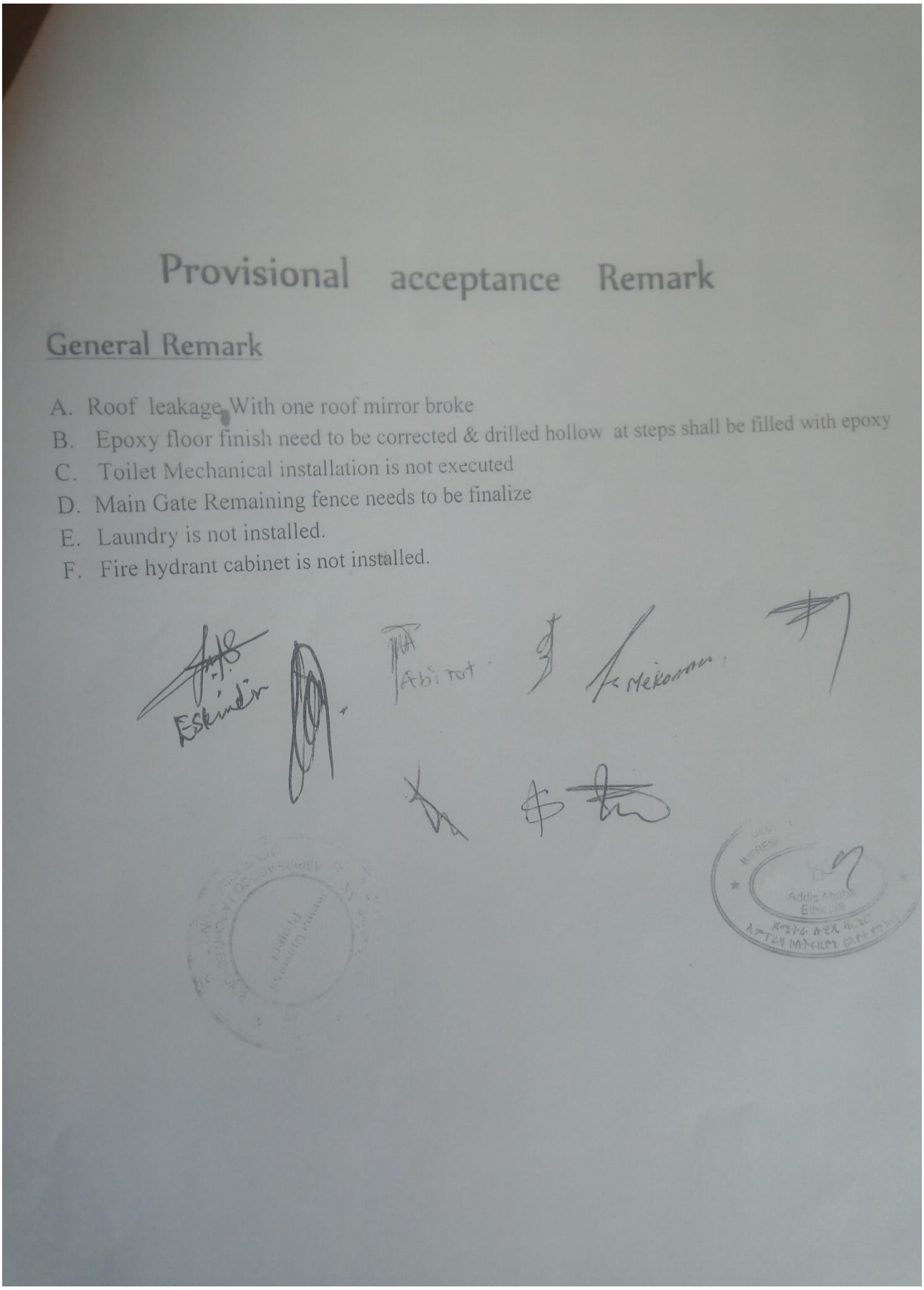
ANNEX-2: Semi-Structure Interview

Dear, first of all I would like to thank you that you cooperate to respond to the interview. I beg your pardon to provide your genuine replies for all questions based on your experience in construction.

Respond the following questions according to based on your experienced.

1. What are some of the most common types of construction defects involved in litigation include during defect liability period in public building construction projects?
2. What are some of the most common Causes of construction defects during defect liability period in public building construction projects?
3. What would be the consequences to the public building if no action is taken seriously against the defects during defect liability period?
4. What are the precautions to reduce defects during defect liability period?
5. Is it possible for a public building construction project to achieve zero defects during defect liability period? How?
6. Retention payment stay with the owner for a long time due to the contractor delay to rectify the defects over 12 months. Do you think that situation affect the owner? How?

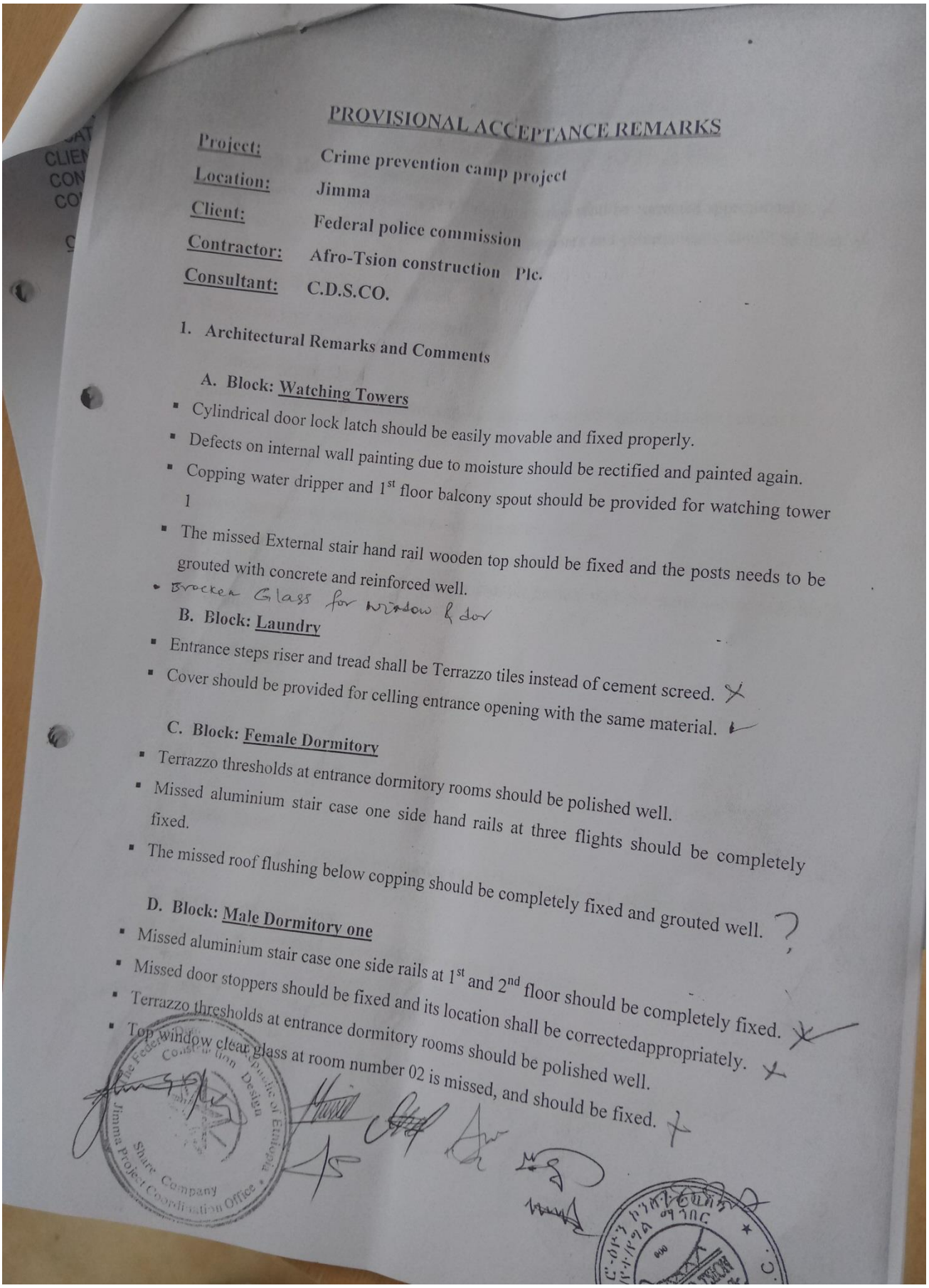
ANNEX-3: Provisional Acceptance Remark



Provisional acceptance Remark

General Remark

A. Roof leakage With one roof mirror broke
B. Epoxy floor finish need to be corrected & drilled hollow at steps shall be filled with epoxy
C. Toilet Mechanical installation is not executed
D. Main Gate Remaining fence needs to be finalize
E. Laundry is not installed.
F. Fire hydrant cabinet is not installed.



PROVISIONAL ACCEPTANCE REMARKS

Project: Crime prevention camp project
Location: Jimma
Client: Federal police commission
Contractor: Afro-Tsion construction Plc.
Consultant: C.D.S.CO.

1. **Architectural Remarks and Comments**

A. Block: Watching Towers

- Cylindrical door lock latch should be easily movable and fixed properly.
- Defects on internal wall painting due to moisture should be rectified and painted again.
- Copping water dripper and 1st floor balcony spout should be provided for watching tower 1
- The missed External stair hand rail wooden top should be fixed and the posts needs to be grouted with concrete and reinforced well.
- Brocken Glass for window & dor

B. Block: Laundry

- Entrance steps riser and tread shall be Terrazzo tiles instead of cement screed.
- Cover should be provided for celling entrance opening with the same material.

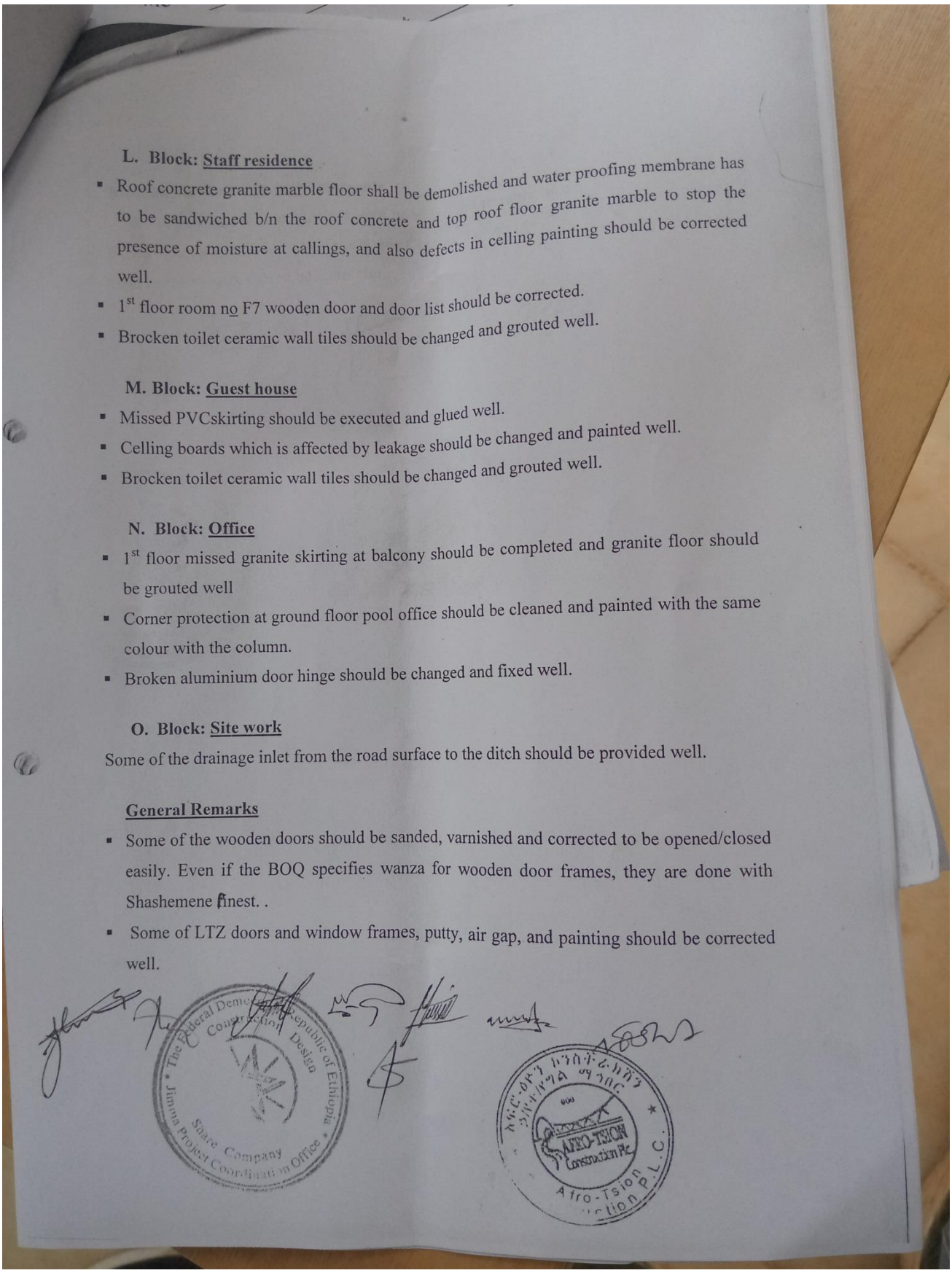
C. Block: Female Dormitory

- Terrazzo thresholds at entrance dormitory rooms should be polished well.
- Missed aluminium stair case one side hand rails at three flights should be completely fixed.
- The missed roof flushing below copping should be completely fixed and grouted well.

D. Block: Male Dormitory one

- Missed aluminium stair case one side rails at 1st and 2nd floor should be completely fixed.
- Missed door stoppers should be fixed and its location shall be correctedappropriately.
- Terrazzo thresholds at entrance dormitory rooms should be polished well.
- Top window clear glass at room number 02 is missed, and should be fixed.

Jimma Project Coordination Office



L. Block: Staff residence

- Roof concrete granite marble floor shall be demolished and water proofing membrane has to be sandwiched b/n the roof concrete and top roof floor granite marble to stop the presence of moisture at callings, and also defects in celling painting should be corrected well.
- 1st floor room no F7 wooden door and door list should be corrected.
- Brocken toilet ceramic wall tiles should be changed and grouted well.

M. Block: Guest house

- Missed PVCskirting should be executed and glued well.
- Celling boards which is affected by leakage should be changed and painted well.
- Brocken toilet ceramic wall tiles should be changed and grouted well.

N. Block: Office

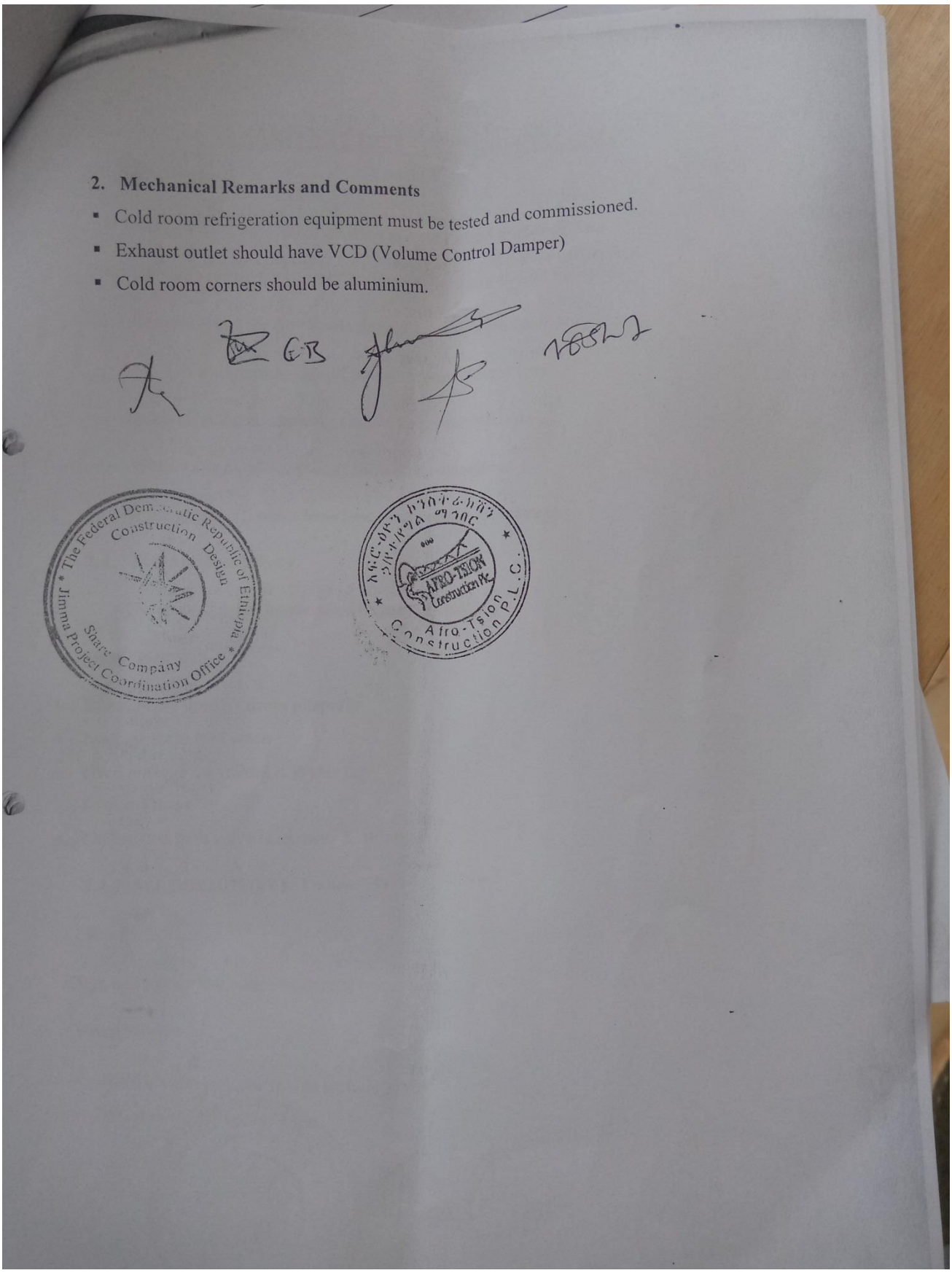
- 1st floor missed granite skirting at balcony should be completed and granite floor should be grouted well
- Corner protection at ground floor pool office should be cleaned and painted with the same colour with the column.
- Broken aluminium door hinge should be changed and fixed well.

O. Block: Site work

Some of the drainage inlet from the road surface to the ditch should be provided well.

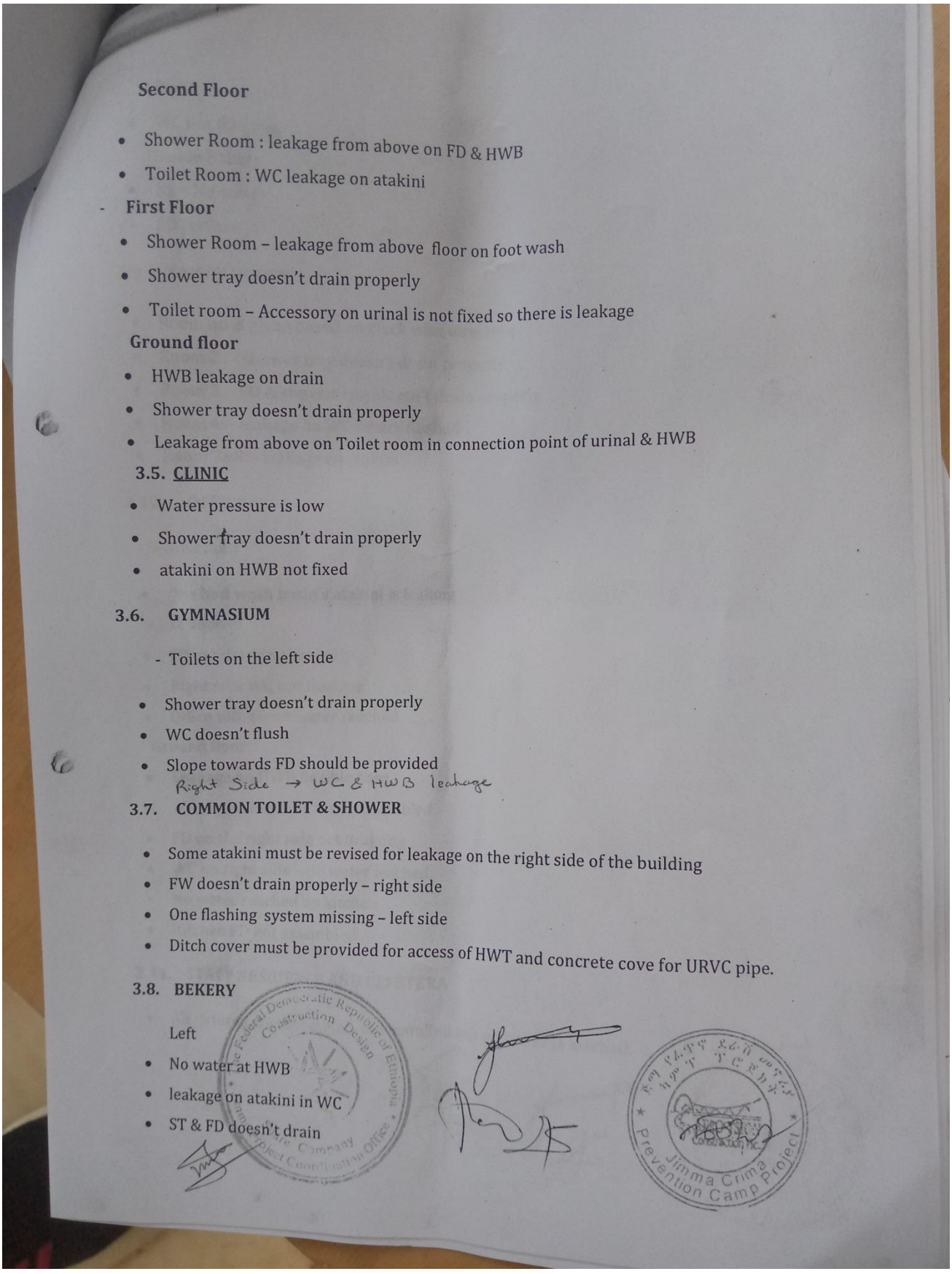
General Remarks

- Some of the wooden doors should be sanded, varnished and corrected to be opened/closed easily. Even if the BOQ specifies wanza for wooden door frames, they are done with Shashemene finest. .
- Some of LTZ doors and window frames, putty, air gap, and painting should be corrected well.



2. **Mechanical Remarks and Comments**

- Cold room refrigeration equipment must be tested and commissioned.
- Exhaust outlet should have VCD (Volume Control Damper)
- Cold room corners should be aluminium.



Second Floor

- Shower Room : leakage from above on FD & HWB
- Toilet Room : WC leakage on atakini

- **First Floor**

- Shower Room – leakage from above floor on foot wash
- Shower tray doesn't drain properly
- Toilet room – Accessory on urinal is not fixed so there is leakage

Ground floor

- HWB leakage on drain
- Shower tray doesn't drain properly
- Leakage from above on Toilet room in connection point of urinal & HWB

3.5. CLINIC

- Water pressure is low
- Shower tray doesn't drain properly
- atakini on HWB not fixed

3.6. GYMNASIUM

- Toilets on the left side

- Shower tray doesn't drain properly
- WC doesn't flush
- Slope towards FD should be provided

Right Side → WC & HWB leakage

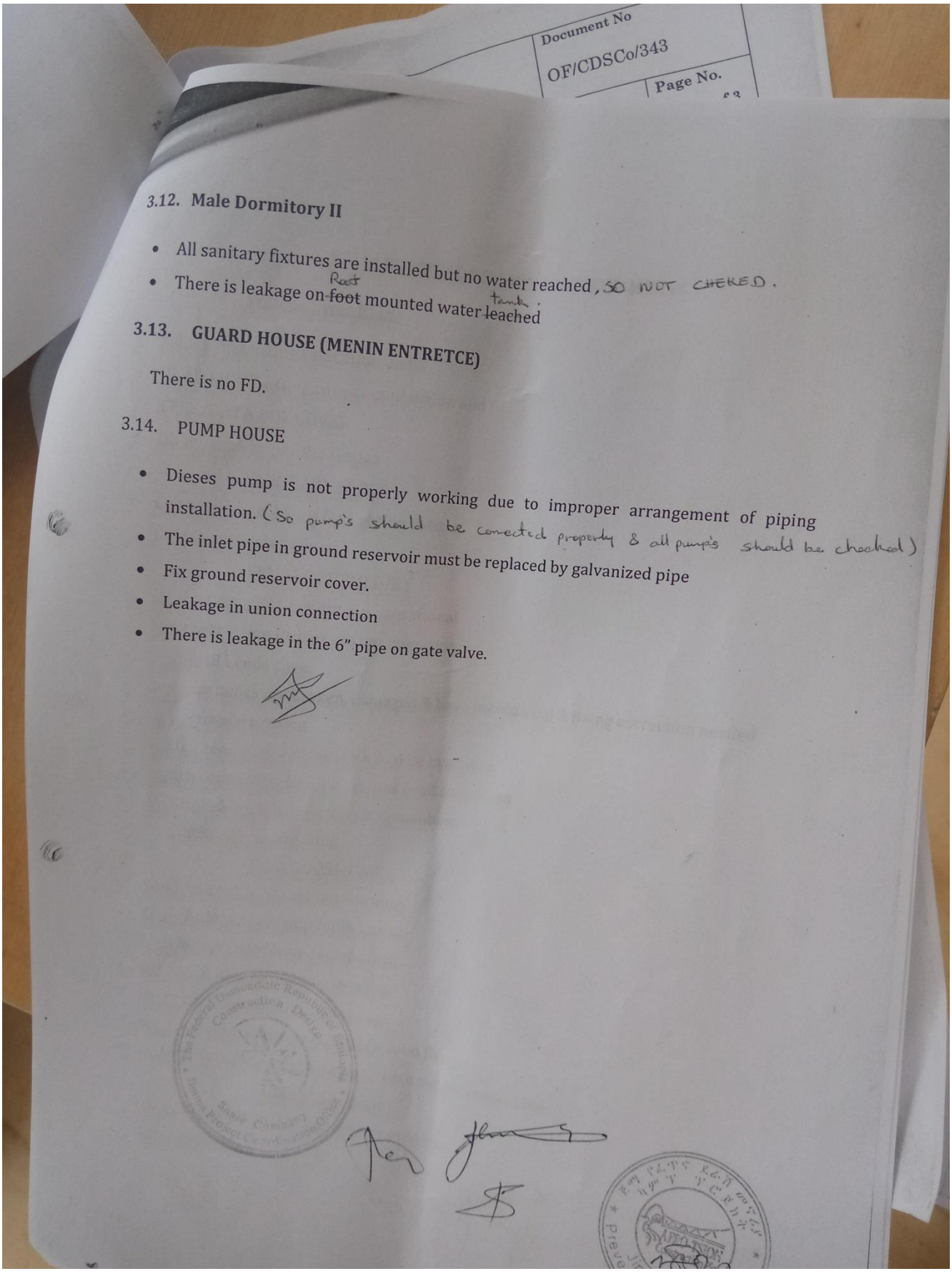
3.7. COMMON TOILET & SHOWER

- Some atakini must be revised for leakage on the right side of the building
- FW doesn't drain properly – right side
- One flashing system missing – left side
- Ditch cover must be provided for access of HWT and concrete cove for URVC pipe.

3.8. BEKERY

Left

- No water at HWB
- leakage on atakini in WC
- ST & FD doesn't drain



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3.12. **Male Dormitory II**

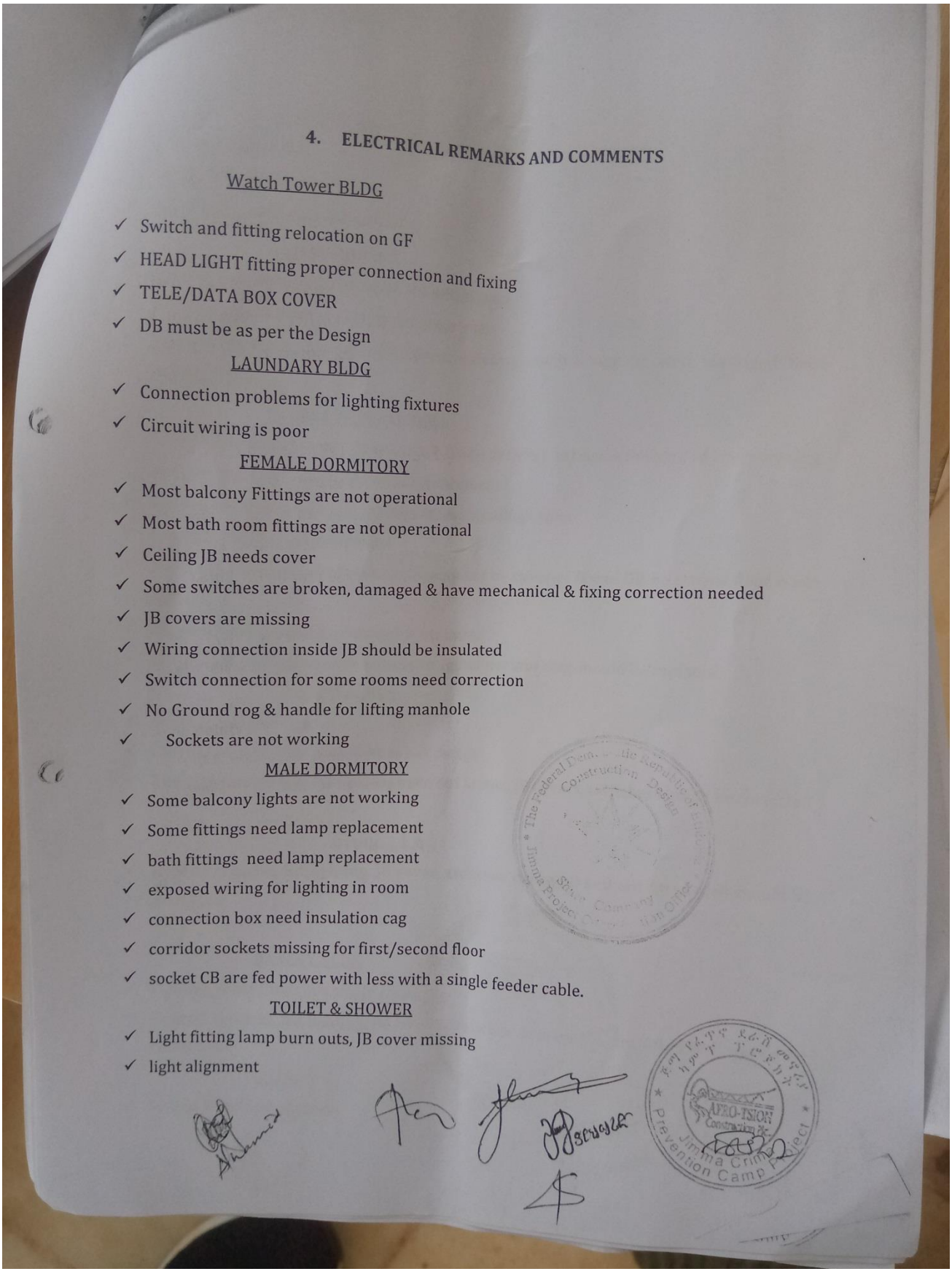
- All sanitary fixtures are installed but no water reached, SO NOT CHEKED.
- There is leakage on ~~foot~~ Roof mounted water ~~leached~~ tank.

3.13. **GUARD HOUSE (MENIN ENTRETCE)**

There is no FD.

3.14. PUMP HOUSE

- Dieses pump is not properly working due to improper arrangement of piping installation. (So pump's should be corrected properly & all pump's should be checked)
- The inlet pipe in ground reservoir must be replaced by galvanized pipe
- Fix ground reservoir cover.
- Leakage in union connection
- There is leakage in the 6" pipe on gate valve.



4. ELECTRICAL REMARKS AND COMMENTS

Watch Tower BLDG

- ✓ Switch and fitting relocation on GF
- ✓ HEAD LIGHT fitting proper connection and fixing
- ✓ TELE/DATA BOX COVER
- ✓ DB must be as per the Design

LAUNDARY BLDG

- ✓ Connection problems for lighting fixtures
- ✓ Circuit wiring is poor

FEMALE DORMITORY

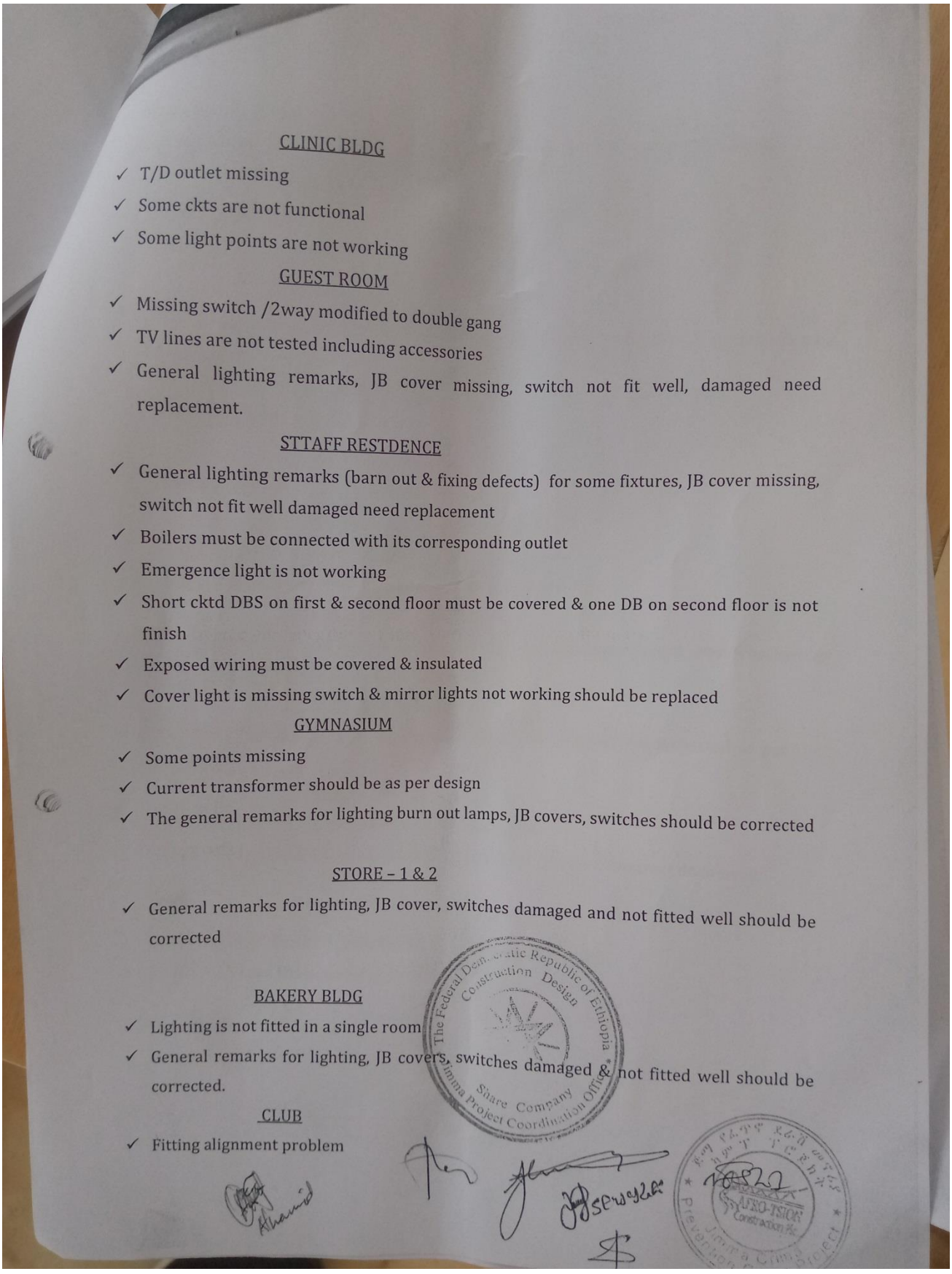
- ✓ Most balcony Fittings are not operational
- ✓ Most bath room fittings are not operational
- ✓ Ceiling JB needs cover
- ✓ Some switches are broken, damaged & have mechanical & fixing correction needed
- ✓ JB covers are missing
- ✓ Wiring connection inside JB should be insulated
- ✓ Switch connection for some rooms need correction
- ✓ No Ground rog & handle for lifting manhole
- ✓ Sockets are not working

MALE DORMITORY

- ✓ Some balcony lights are not working
- ✓ Some fittings need lamp replacement
- ✓ bath fittings need lamp replacement
- ✓ exposed wiring for lighting in room
- ✓ connection box need insulation cag
- ✓ corridor sockets missing for first/second floor
- ✓ socket CB are fed power with less with a single feeder cable.

TOILET & SHOWER

- ✓ Light fitting lamp burn outs, JB cover missing
- ✓ light alignment



CLINIC BLDG

- ✓ T/D outlet missing
- ✓ Some ckts are not functional
- ✓ Some light points are not working

GUEST ROOM

- ✓ Missing switch /2way modified to double gang
- ✓ TV lines are not tested including accessories
- ✓ General lighting remarks, JB cover missing, switch not fit well, damaged need replacement.

STTAFF RESTDENCE

- ✓ General lighting remarks (barn out & fixing defects) for some fixtures, JB cover missing, switch not fit well damaged need replacement
- ✓ Boilers must be connected with its corresponding outlet
- ✓ Emergence light is not working
- ✓ Short cktd DBS on first & second floor must be covered & one DB on second floor is not finish
- ✓ Exposed wiring must be covered & insulated
- ✓ Cover light is missing switch & mirror lights not working should be replaced

GYMNASIUM

- ✓ Some points missing
- ✓ Current transformer should be as per design
- ✓ The general remarks for lighting burn out lamps, JB covers, switches should be corrected

STORE – 1 & 2

- ✓ General remarks for lighting, JB cover, switches damaged and not fitted well should be corrected

BAKERY BLDG

- ✓ Lighting is not fitted in a single room
- ✓ General remarks for lighting, JB covers, switches damaged & not fitted well should be corrected.

CLUB

- ✓ Fitting alignment problem

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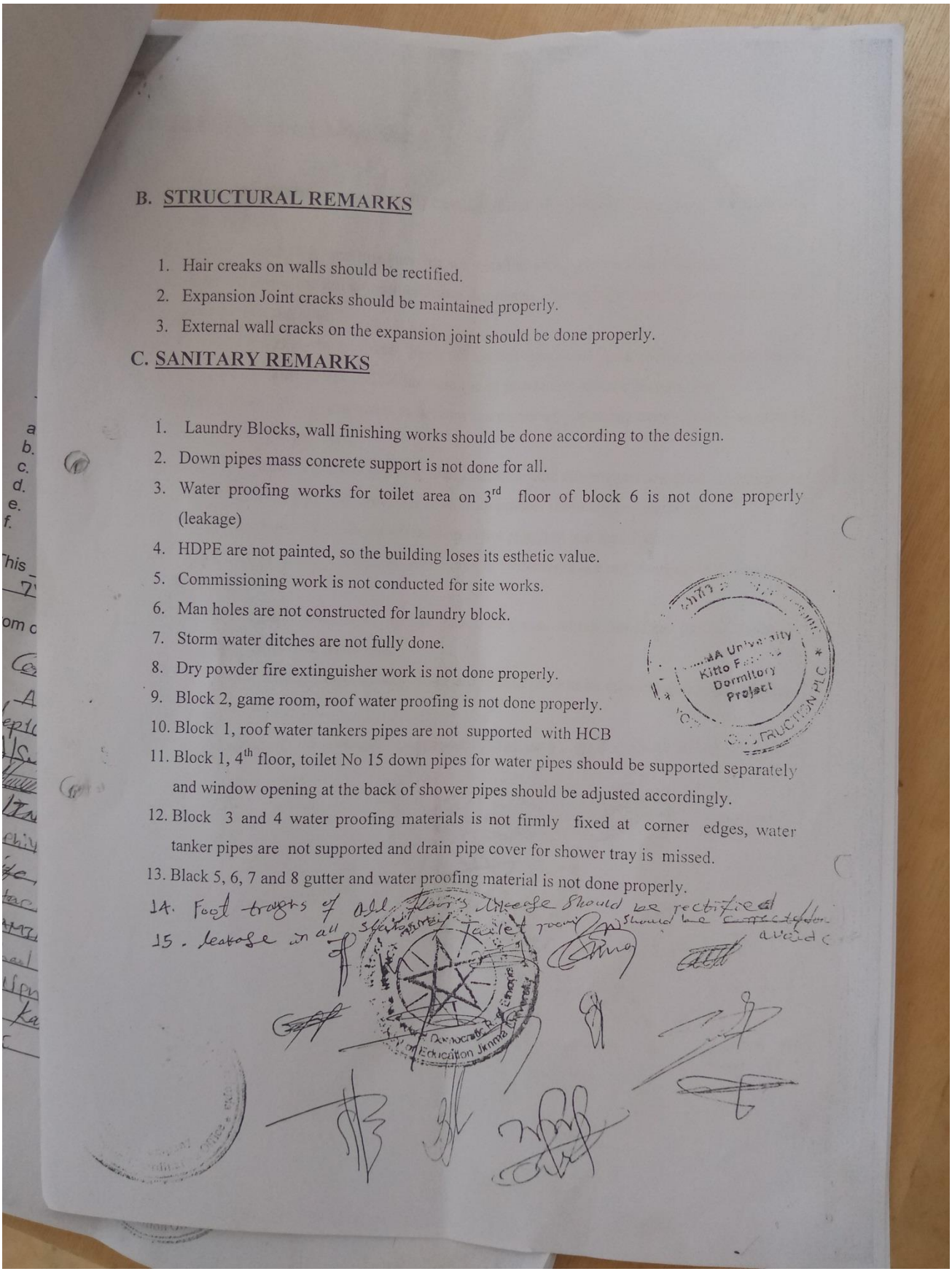

B. STRUCTURAL REMARKS

1. Hair creaks on walls should be rectified.
2. Expansion Joint cracks should be maintained properly.
3. External wall cracks on the expansion joint should be done properly.

C. SANITARY REMARKS

1. Laundry Blocks, wall finishing works should be done according to the design.
2. Down pipes mass concrete support is not done for all.
3. Water proofing works for toilet area on 3rd floor of block 6 is not done properly (leakage)
4. HDPE are not painted, so the building loses its esthetic value.
5. Commissioning work is not conducted for site works.
6. Man holes are not constructed for laundry block.
7. Storm water ditches are not fully done.
8. Dry powder fire extinguisher work is not done properly.
9. Block 2, game room, roof water proofing is not done properly.
10. Block 1, roof water tankers pipes are not supported with HCB
11. Block 1, 4th floor, toilet No 15 down pipes for water pipes should be supported separately and window opening at the back of shower pipes should be adjusted accordingly.
12. Block 3 and 4 water proofing materials is not firmly fixed at corner edges, water tanker pipes are not supported and drain pipe cover for shower tray is missed.
13. Black 5, 6, 7 and 8 gutter and water proofing material is not done properly.
14. Foot troughs of all floors Urinage Should be rectified
15. leakage in all shower toilet room should be