ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

CONSTRUCTION COST ESTIMATION GUIDELINE FOR LOCAL CONTRACTORS IN ETHIOPIA

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A thesis submitted to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Science in Construction Technology and Management.

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ABSTRACT

Cost estimation is one of the most important steps in the process of construction project execution whereby an organization interested in the construction of a project attempts to estimate the expected expenditure of resources such as materials, manpower, machineries, finance and time in advance necessarily to realize the intended project.

Construction cost estimation helps project owners in such a way decision can be made to finance or shelf the intended project. Incase, the owner decides to finance the project, the next task is either to execute the construction works on force account or outsource these works to a capable contractor who can deliver the project with the lowest possible construction cost, high quality of works and shortest time possible.

However, it is usually difficult and challenging for contractors to satisfy higher quality and shorter time requirements of project owners with lowest construction costs. On the other hand, unless a contractor offers the lowest possible construction cost, there is high tendency of losing the competition to get the intended construction project and becoming out of business.

Therefore, contractors' construction cost estimation shall be competent in order to get the intended project and at the same time these estimates shall be accurate enough in order to keep the profitability of the construction company. Moreover, competent construction cost estimate is also vital to project owners in such a way it addresses properly the required quality of works, time for completion as well as reasonable cost of construction.

As a result, this thesis work mainly focuses on how to develop and establish the unit costs of construction project activities as well as the overall estimated construction costs of a project.

Key words: Direct material cost, Direct labor cost, Direct equipment cost, Head office overhead cost, Site overhead cost, Risk allowance, Profit and income tax.

1 – RESEARCH BACKGROUND

Construction projects involve various types of costs to the owner in its lifetime, which are broadly categorized as the initial capital costs and the subsequent operation and maintenance costs. The capital costs for a construction project include all expenses related to the initial establishment of the project such as expenses related to:

- ✓ Planning and feasibility studies
- ✓ Land acquisition
- ✓ Architectural and engineering design
- ✓ Construction, including materials, equipment and labor
- ✓ Construction supervision
- ✓ Construction financing
- ✓ Insurance and taxes during construction
- ✓ Owner's general office overhead
- ✓ Equipment and furnishings not included in construction
- ✓ Inspection, testing and commissioning

The operation and maintenance costs are also all expenses of the facility in the subsequent years during the life time of the project after the final testing and commissioning of the construction phase and these operation and maintenance costs include expenses related to:

- ✓ Land rent, if applicable
- ✓ Operating staff
- ✓ Labor, equipment and material for maintenance and repairs
- ✓ Periodic renovations
- ✓ Insurance and taxes
- ✓ Financing costs
- ✓ Utilities
- ✓ Owner's overhead and other expenses

The magnitude of each of these cost components depends on the nature, size and location of the project. In most large civil engineering projects such as hydropower projects, construction cost is the single largest component of the capital costs. In other instances, land acquisition cost can be the major expenditure for building construction projects in high densely populated urban areas. It is also possible that construction financing costs can reach the same order of magnitude as that of the construction costs in large projects such as construction of nuclear power plants. Moreover, from the owner's perspective, it is also equally important to estimate the corresponding operation and maintenance costs of each alternatives of a project in order to analyze the total life cycle costs of the project.

Therefore, in order to decide whether to finance a proposed project or not, owners shall clearly understand and identify all project related costs starting from the feasibility study up to the final testing and commissioning as well as the operational and maintenance costs. Once the project owner has proved the intended project is feasible and accordingly made arrangements to finance the project, the single most important task remaining is to find a capable contractor who can deliver the construction phase of the project with the lowest possible construction cost, high quality of works and shortest time possible. For this purpose, project owners usually select contractors based on technical and financial competitions.

As a contractor, in addition to all technical and managerial capabilities, it is usually difficult and challenging to satisfy the quality and time requirements of the project owner with lowest construction costs. On the other hand, unless a contractor offers the lowest possible construction price, there is high tendency of losing the competition and becoming out of business. Therefore, competent construction cost estimates are vital both to the contractor and the project owner which enables the execution of the project to the quality standards and time tables set by the owner with reasonable construction costs.

In Ethiopia, almost all governmental, public and private projects are constructed by contractors based on the conventional design, bid and build procedures whereby the project owners prepare bidding documents which include all necessary drawings, technical specifications, estimated bill of quantities, general and particular conditions of contract and contractors compete based on these bidding documents to get the construction projects based on their submitted tender prices. The sole basis of these tender prices is the contractor's unit price of each work item in the estimated bill of quantities.

In the process of bidding, the main objective of a project owner is to find a potential contractor with the lowest possible tender price and who can execute the project to the satisfaction of the quality standards stated in the drawings and technical specifications as well as complete the works within in the time frame stated in the bidding documents.

Therefore, in estimating the unit price of each activity in the estimated bill of quantities, the contractor's cost estimate shall be competent in order to get the intended project and at the same time these estimates shall be accurate enough in order to keep the profitability of the construction company.

As a result, this thesis will mainly focus on how to develop the unit construction costs of an activity and obtain the total construction cost estimation for local construction projects in Ethiopia.

1-1 – CONSTRUCTION COST ESTIMATION PRACTICE IN ETHIOPIA

Generally, the former Ethiopian Building Construction Authority (EBCA) and the Ethiopian Transport Construction Authority (ETCA) currently called the Ethiopian Roads Authority (ERA) have laid the foundation for proper construction cost estimations in Ethiopia.

The Ethiopian Building Construction Authority has prepared material consumption breakdowns and performance standards for the most commonly used activities in building projects. With the same manner, the Ethiopian Transport Construction Authority has also prepared performance standards for each major activity undertaken on road construction projects.

However, even though, those two governmental institutions have prepared basic start up performance standards for building and road construction works, no major researches and improvements have been done for decades on those performance standards while there are many major changes related to the type and quality of construction materials, type and capacity as well as productivity of construction equipments, skill of construction labor and overall construction methods and technologies.

In most cases, local contractors are using the Ethiopian Building Construction Authority performance standards and material breakdowns as a sole basis for estimating building project construction costs and the Ethiopian Transport Construction Authority performance standards and material breakdowns are also used as a sole basis for estimating road project construction costs.

Moreover, there are many instances whereby contractors use previously prepared unit prices by other contractors whom they believed are well organized contractors in estimating project construction costs without justification of the cost components included in these unit prices. In addition, most local contractors of different classes use about thirty percent (30%) of their direct costs to cover overhead costs and profit margins in their project estimates without justification.

There are also contractors who use the Engineer's estimate as their absolute basis and try to fix the project construction cost estimate to be equivalent to the lower margin of the bidding criteria as compared to the engineer's estimate. However, the Engineer's project construction cost estimate itself is not reliable as the local consultants cost estimation practice is in a similar level with that of the local contractors. As a matter of fact, most governmental and public projects use the following bid evaluation criteria in evaluating the financial proposals of bidding contractors.

STEP 1 - Bid offers below and above twenty percent (20%) of the Engineer's estimate shall be considered as none responsive and shall not be considered for further evaluation.

STEP 2 - If the number of responsive contractors are three and above, twenty five percent (25%) of the Engineer's estimate and seventy five percent (75%) of the bidders' average shall be taken as final adjusted project estimate. However, if the number of responsive contractors are only two, thirty three percent (33%) of the Engineer's estimate and sixty seven percent (67%) of the bidders' average shall be taken as final adjusted project estimate. Moreover, if the number of responsive contractor is only one, fifty percent (50%) of the Engineer's estimate as well as fifty percent (50%) of the bidder's estimate shall be taken as final adjusted project estimate.

STEP 3 - A bid offer below or above fifteen percent (15%) of the adjusted project estimate shall not be considered for contract award.

Generally, the local construction cost estimation practice clearly indicates that the local knowledge and experience of construction cost estimation of the local contractors and consultants is very poor and on top of all other managerial, economic, political and social factors, this poor construction cost estimation practice has contributed its own negative impact on the national economy as well as development of the local construction industry and most local contractors are delivering poor quality and delayed projects as well as suffering bankruptcy. There are also cases whereby projects are executed at excessively higher construction costs from time to time.

1-2 – RESEARCH OBJECTIVE

Based on the current local construction cost estimation practices, it is very clear that the local construction industry lacks properly organized construction cost estimation guidelines.

Therefore, the main objective of this research work is to prepare a construction cost estimation guideline on how to establish the unit costs of construction activities and develop the overall project construction costs.

In the preparation of this construction cost estimation guideline, the establishment of unit costs for the following major construction cost components will be discussed in detail with relevant examples.

- ✓ Direct labor costs
- ✓ Direct material costs
- ✓ Direct equipment costs
- ✓ Site overhead costs
- ✓ Head office overhead costs
- ✓ Risk allowance
- ✓ Profit margins
- ✓ Income tax

1-3 – RESEARCH APPLICATION

As clearly stated in the research objective, the outcomes of this research work will be applicable in the construction industry mainly in the preparation of construction cost estimates for different building, industrial and engineered construction projects.

Therefore, the outcomes of this research work is intended to serve mainly as a reference material in the preparation of construction cost estimates for different local construction projects in Ethiopia and it is believed that the following particular stakeholders, but not limited to, will benefit from this research work.

- ✓ Local contractors
- ✓ Local consultants
- ✓ Governmental offices
- ✓ Higher Institutions
- ✓ Public and private sectors
- ✓ Engineers and Architects
- ✓ As well as other interested stakeholders

2 - LITERATURE SURVEY

Construction cost estimation is a process whereby an organization interested in the construction of a project attempts to determine the expenditure of resources such as materials, manpower, machineries, finance and time necessarily to realize the intended project.

The quality and accuracy of construction cost estimation can be continually improved as the construction execution progresses where more detailed and actual data become available. However, the cost estimation of construction projects shall be prepared before the execution of the project for different fundamental reasons such as:

- ⇨ The project owner shall usually obtain the construction cost estimation of his project in advance to decide on realization of the project and commit accordingly to finance for its execution.

- ⇨ In most cases, construction projects are executed by contractors whereby the Employer shall have contractual agreements with the contractor based on the agreed construction cost estimates before the execution of the contract.

Therefore, this implies that accurate construction cost estimates are vital for the proper execution of construction projects whereby both the project owner and the contractor benefits from the project. Poor cost estimates of construction projects may damage heavily the project owner and/or the contractor whereby the performance of the contract in between will involve endless disputes with irrecoverable money and time.

Construction cost estimation techniques may vary from organization to organization involving different varieties of data, formats and costing procedures and each cost estimator may also add his/her own art in the preparation of these construction cost estimates of a specific project. Whatever cost estimation procedures are followed in estimating the construction costs of a project, the cost estimator must be experienced in the intended type of construction project and have the ability to work in depth and accurately to identify the hidden costs of the project.

The two most interested parties in the cost estimation of a construction project are the owner, who will have to pay for the construction of the project and the contractor, who must determine a price to charge the owner with all the anticipated construction costs including profit, income tax and risk allowances. Moreover, there are also others who may have an interest in the construction cost estimates such as the consultants who must design the project within the

owner's budget as well as international and local financers who are interested to finance the intended project.

Generally, the construction cost estimation of a project as well as the estimation techniques and procedures to be followed mainly depend on the type of construction projects, methods of tendering and type of construction contracts.

2-1 – TYPE OF CONSTRUCTION PROJECTS

Construction projects are usually classified under three main categories namely Building constructions, Heavy or Engineered constructions and Industrial constructions.

Construction of residential houses, commercial buildings, social buildings and institutional buildings are normally categorized as building constructions or vertical constructions. Construction of highways, dams, underground tunnels, airports and the like are categorized as heavy constructions, horizontal constructions or engineered constructions. Moreover, the construction of factories of any kind, refineries and the like are also categorized under the industrial constructions which is basically in between heavy and building constructions.

Construction cost estimation for building construction projects is relatively easier and more accurate than for heavy and industrial constructions due to the following major reasons:

a) Building construction projects involve greater use of standard designs, materials and construction practices. Moreover, site visits and exploration works, if required, can be conducted relatively much easier than heavy and industrial construction sites.

b) Building construction projects are also usually in cities and towns where a working relationship already exists with the local workforce, subcontractors, materials and equipment suppliers.

c) Building construction projects often involve repetition of construction operations from floor to floor, site to site and so on.

d) Equipments used in building construction projects are usually relatively very few in number and easy to repair or replace as compared to the equipments used in heavy construction projects.

e) Building construction projects usually involve minimal mobilization and demobilization works.

f) Moreover, building construction projects involve relatively minimal site facilities such as residence camps for site staffs and workers, offices, access roads, water and power supplies and the like.

On the other hand, construction cost estimation for heavy construction projects is more complicated as compared to that of the building construction projects in such a way:

1) Heavy construction projects are often carried on remote locations where the construction site is far from labor force pools, materials and equipments suppliers which in turn initiate huge mobilization and demobilization works.

2) Heavy construction projects usually involve the construction of temporary residential camps, offices, detour roads, access roads, water and power supplies as well as other facilities.

3) Heavy construction projects also involve wide varieties of machineries and plants where operations and maintenance management require qualified and experienced management techniques.

4) Heavy construction projects usually involve unique construction techniques, which makes it difficult to get experienced skilled manpower and in most cases require extra cost and time to train in-house workers.

5) Heavy construction projects require vast experience in preparation of method statements as well as estimating crew productivities.

6) Heavy construction projects such as hydropower projects also involve wide varieties of imported materials where material specifications could be new to cost estimating staffs and so on.

2-2 – METHODS OF TENDERING

Most project owners prefer to select contractors based on competitive tendering to get the lowest possible offers. Even though competitive tendering is the most commonly used method of tendering, there are also other tendering methods with specific merits and demerits both to the owners and the contractors. The most commonly used tendering methods are open tendering, selective tendering, serial tendering and negotiation tendering.

The method of tendering directly affects the cost estimation of construction projects as well as cost estimating techniques to be adapted. Moreover, the quality of works and construction time required are also indirectly affected as a result of the tendering methods adapted by the owner.

2-2-1 – OPEN TENDERING

In the case of open tendering, all interested contractors are invited to participate in the intended project bid. Announcements are made usually in newspapers and electronic media depending on the size and urgency of the project. Due to the expected long list of interested contractors, bid documents are usually sold at certain prices, which help to return the bid document preparation costs of the owner and to attract only those contractors who are really interested in the construction of the intended project.

Open tendering is adapted strictly usually for public and governmental projects and it has the following advantages to the project owner:

a) It allows all interested contractors to compete on equal grounds and potentially strong new contractors may appear in the competition.

b) It gives the opportunity for local authorities to demonstrate the best bargain possible for public and government money and assures fairness in selecting contractors.

c) It helps to prevent contractors from forming rings i.e. agreeing on offers to be submitted to the owner due to the long list of contractors and may not know each other.

d) The owner may obtain the least possible construction cost estimates due to the tight price competition among long list of contractors.

On the contrary to the above advantages, open tendering has also the following disadvantages:

1) Due to the long list of contractors, tender evaluation will take longer time usually in months incurring additional overhead costs to the owner and extending unnecessarily the commencement time of the intended project.

2) Public accountability may be questioned, if the lowest offer is not accepted during the financial evaluation of tenders.

3) Contractors with ill-equipped management may submit the lowest offer and inevitably the contract can drag out causing delay and incurring additional cost to the owner.

4) If the submitted tender price is too low and the contractor is losing money, then the contractor may try to reduce the quality of works and submit enormous claims in an attempt to recover the realized loss, which usually results in deterioration of the relationships among the contracting parties.

5) It is also very normal that qualified and experienced contractors may not participate in the tender knowing that the competition will be very tight with unknown contractors of their financial and technical capacity.

Generally, in open tendering, the contractors' construction cost estimates shall be very accurate not to loose the project and not loose money in the project due to the tight mainly of financial competition among long list of contractors.

2-2-2 – SELECTIVE TENDERING

In the selective method of tendering, short list of contractors are invited to participate in the tender for an intended project. The short list of contractors is usually prepared based on different criteria such as contractor's previous reputation in business, financial standing, available resources especially of machineries and manpower, normal conduct of business i.e. the specialization of the contractor, attitude on contractual claims, non-economic factors such as local contractors preference and so many other factors depending on the interest of the project owner.

In most cases, list of capable contractors are usually selected during the prequalification stage of the tendering process. This method has its own impact on the project cost estimation, quality of works and time for completion.

The selective tendering has the following advantages to the project owner:

a) Competent contractors are participating in the tender and it is fair to select the contractor with the lowest offer.

b) It reduces the time and overhead cost of tender evaluation and facilitate the early commencement and completion of the project.

The selective tendering has also the following disadvantages to the owner:

1) Tender prices are inevitably higher than would have been under open tendering due to the limited number of competing contractors.

2) Contractors who are not interested in the tender may submit high prices rather than withdrawing from the tender not to remove their names in the subsequent tender lists. This gives additional opportunity for other contractors with high prices to get the project.

3) There is a great chance of forming rings among contractors unless the composition of the list of contractors is variable for each tender.

4) Care shall be taken to ensure no favoritism in inclusion and exclusion of contractors from the short list especially in public and governmental projects.

Unlike the open tendering, the selective tendering gives the opportunity for contractors to know their competitors and previous experience of these competitors will greatly help the contractor in determining the construction cost estimation strategy of the intended project.

2-2-3 – SERIAL TENDERING

Serial tendering is more applicable when the owner has a continuing construction program of similar projects such as housing projects, schools, health centers and so on. Contractors are invited to participate in a tender with the basic understanding that successful contractors will enter into a series of contracts with the same conditions contained in the tender.

The advantages of serial tendering are:

a) Lower tender prices can be obtained, if the competition is open to all contractors.

b) It allows the owner and the contractor to program works in advance with more certainty.

c) It generally creates a better relationship between the owner and the contractor in such a way contractors usually contribute advice in planning of future works.

d) It allows the contractor more time to plan, organize and coordinate his resources and experience for the next projects enabling a more efficient way of performing the future contracts.

The main disadvantage of serial tendering is that it has the tendency of reducing work available, under competition, to other contractors.

In this type of tendering, contractors should also consider the future economic factors such as cost of materials, machineries and manpower in the future as series of projects will be executed with the current cost estimates.

2-2-4 – NEGOTIATION TENDERING

Negotiation tendering is usually applicable when a specific contractor owns special managerial and unique technical skills. Moreover, it is also applicable in urgent works such as dam repair works whereby it requires to be maintained in

very short period of time before total failure occurs. In this case, negotiation can be held with capable contractor nearer to the site, if possible with the contractor who built the dam project.

The advantages of negotiation tendering are:

a) The contractor can participate starting from design stage contributing his experience for a better quality and performance of works.

b) It allows early commencement and completion of projects with a better understanding of the contracting parties.

The main disadvantage of negotiation tendering is that contractors will offer higher tender prices. In this case, cost estimators will estimate construction cost of projects with full freedom ignoring inputs from competitors in their cost estimation techniques.

2-3 – TYPES OF CONSTRUCTION CONTRACTS

Similar with that of methods of tendering, construction contracts have direct impact on the cost estimation of construction projects. There are many types of construction contracts, which are applicable based on the prevailing specific project conditions and largely the interest of the owner, as listed below:

- ✓ Lump sum fixed price contract
- ✓ Lump sum fixed price and escalation contract
- ✓ Lump sum fixed price and schedule rate contract
- ✓ Lump sum fixed price with escalation and schedule rate contract
- ✓ Unit rate contract
- ✓ Unit rate and escalation contract
- ✓ Schedule rate contract
- ✓ Schedule rate and escalation contract
- ✓ Cost plus percentage of cost contract
- ✓ Cost plus fixed fee contract
- ✓ Cost plus percentage of cost with guaranteed maximum cost contract
- ✓ Cost plus fixed fee with guaranteed maximum cost contract
- ✓ Target cost incentive contract

2-3-1 – LUMP SUM FIXED PRICE CONTRACT

In the lump sum fixed price contract, the contractor agrees to execute the project based on a fixed lump sum price which is not subject to any variations unless the drawings and specifications are altered beyond the maximum limit stated in the contract conditions by the owner.

The contractor is fully responsible to quantify the volume of works based on the given specifications and drawings. Overestimating the volume of works will result in loosing the job, if it is on competitive basis and underestimating the volume of works will result irreversible loss, which can not be corrected during the execution of the contract at any level.

Moreover, the contractor must be in a position to estimate the influence of cost escalation in the future during the execution of the project and these anticipated additional costs should be incorporated in the tender prices.

Contractors are advised to enter in to this kind of construction contracts when the firm has sound previous construction experience of similar technical and contractual nature.

The main advantage of lump sum fixed price contract is that the owner knows the budget of his/her project in advance and clear decision can be made whether to finance or shelve the project.

On the other hand, lump sum fixed price contract has many disadvantages whereby some of these disadvantages are listed below:

a) All competing contractors are required to carry out enormous take off works where only one contractor will be successful. It consumes excessive time of the contractors' cost estimation team and contractors are usually not interested to participate in such kind of tenders.

b) All bidding documents such as the technical specifications and drawings have to be clearly prepared and delivered during tendering stage to the contractor.

c) Claims and variation works are very difficult to handle in this kind of construction contracts due to the absence of agreed unit rates.

d) Contractors tend to include higher percentages of contingencies in their tender prices to cover price escalation, take off errors, clarity of drawings and specifications which inevitably raises the tender prices.

e) Unless the bidding documents are sound and sufficient enough to define the intended projects, contractors may not compete on the same ground.

2-3-2 – LUMP SUM FIXED PRICE and ESCALATION CONTRACT

Lump sum fixed price and escalation contract is basically the same as that of the lump sum fixed price contract except it includes allowances for price escalations. This type of construction contract contains a provision whereby the contract value

can be adjusted based on the specified price indices included in the contract. Such construction contracts usually reduce the risk to the contractor during periods of high inflation.

The inclusion of price escalation provision also benefits the owner in terms of getting lower tender prices in such a way contractors usually add large contingencies for price escalations. Therefore, in order to have competent tender prices, contractors shall not account contingencies for price escalations in their tender prices in dealing with lump sum fixed price and escalation contracts.

2-3-3 – LUMP SUM FIXED PRICE and SCHEDULE RATE CONTRACT

This is another extension of lump sum fixed price contract but it incorporates unit prices of different activities which will help to manage variation works and claims during execution of the project. Moreover, the contractor shall not account contingencies for additional works and claims but contingencies for price escalation of materials, labor and equipments shall be considered in the tender prices.

2-3-4 – LUMP SUM FIXED PRICE with ESCALATION and SCHEDULE RATE CONTRACT

The lump sum fixed price with escalation and schedule rate contract minimizes the inclusion of contingencies in tender prices by contractors. In this case, contractors shall not account contingencies in their tender prices for additional works and claims as well as price escalations. Moreover, price escalations, variation works and claims are better handled in this type contract during the execution of the project.

2-3-5 – UNIT RATE CONTRACT

The unit rate contract is also called item rate contract. In this case, the construction contract is based on priced bill of quantities whereby estimated quantities of certain well defined work items and fixed unit prices of each of these defined work items are agreed upon. The estimated quantities may increase or decrease during the execution of the project and the contractor is obliged to accept these variations without additional costs as far as these variations in quantity are within the agreed limits with the owner.

The unit rate contract is the most commonly used for all public and governmental projects whereby the estimated quantities and specifications of works are well known in advance.

The advantages of unit rate contract are:

a) There is no need for detailed drawings as in the case of lump sum contracts and these detailed drawings can be prepared after the award of the contract.

b) Changes in drawings and quantities can be made as required by the owner within the agreed limits.

c) Additional works and claims can be handled in a better way especially when the priced bill of quantities includes these additional work items and claims.

d) It gives a better opportunity to compete on the same grounds.

The disadvantages of unit rate contract are:

1) The total cost of the project can only be known upon completion of the project whereby the owner may incur financial difficulties in financing the project.

2) The contract doesn't contain provision for price escalation and the contractor may increase his construction cost estimates including price escalation contingencies for future price escalations of labor, materials and equipments.

3) Clearly defined work specifications shall be prepared in advance and issued with the bidding documents to contractors participating in the tender.

4) The preparation of technical specifications and estimated bill of quantities may take longer time, which will affect the overall completion of the intended project.

Therefore, in this type of contract, contractors shall focus mainly on the cost analysis of each unit of work stated in the bid documents rather than the total cost of the project as in the case of lump sum fixed price contract. The cost estimator shall also consider anticipated price escalations in the future and include these contingencies in his unit cost analysis.

Moreover, even though, estimated quantities are given by the owner in the bidding documents, it is usually advisable to cross check these estimated quantities with the given drawings and specification to establish proper cost estimation strategies for each construction project.

2-2-6 – UNIT RATE and ESCALATION CONTRACT

The unit rate and escalation contract is generally the same with unit rate contract except it contains a provision for price escalations based on specified price indices. Such provisions reduce the risk to the contractor during periods of rapid inflation and it also benefit to the owner in terms of getting lower tender prices in such a way contractors usually add large contingencies for price escalations.

In this type of contract, contractors are not advised to consider future price escalations in their unit cost analysis to develop a better competent tender price.

2-2-7 – SCHEDULE RATE CONTRACT

Basically, the schedule rate contract is based on only agreed unit prices of the intended work items with out estimated quantities of the works. In this type of contract, detailed work specifications and general drawings are usually used during tendering.

Advantages of schedule rate contract are:

a) There is no need for detailed drawings and these detailed drawings can be prepared after the award of the contract, which gives the opportunity to carry out detail designs and construction of the project at the same time shortening the overall completion of the project.

b) Changes in drawings and quantities can be made as required by the owner without limits.

c) Additional works and claims can be handled in a better way than all other type of contracts without limit especially when the schedule rate contract includes these additional work items and claims.

Disadvantages of schedule rate contract are:

1) The total cost of the project can only be known upon completion of the project and the owner does not even have indicative cost of the project as that of the unit rate contract.

2) This construction contract doesn't contain provision for price escalation whereby the contractor may increase his construction cost estimates including contingencies for future price escalations of labor, materials and equipments.

3) Clearly defined and detailed technical specifications shall be prepared in advance and issued with the bidding documents to contractors participating in the tender.

4) It is very difficult to evaluate and select a better offer from different tender offers in the absence of estimated bill of quantities.

In the schedule rate contract, the contractor's cost estimator shall focus on the cost analysis of each unit of work given in the schedule of items. The contractor shall also consider anticipated price escalations in the future and include these contingencies in his unit cost analysis.

2-2-8 – SCHEDULE RATE and ESCALATION CONTRACT

The schedule rate and escalation contract is a continuation of the schedule rate contract except it contains a provision for price escalation based on specified price indices as discussed for all the other types of contracts. In this type of contract, contractors are not advised to consider future price escalations in their unit cost analysis to develop a better competent tender price.

2-2-9 – COST PLUS PERCENTAGE OF COST CONTRACT

In the cost plus percentage of cost contract, the contract is agreed between the owner and the contractor based on the actual direct cost records plus agreed percentage of these actual direct costs expended by the contractor to cover overhead costs as well as profit and income tax.

Cost plus percentage of cost contracts are usually suitable when the nature of the work may be such that it is impossible or impracticable to prepare complete drawings and specification due to unusually pressing speed of construction is required or major changes during construction are expected such as finishing works which may deteriorate the agreed contract or it may be difficult to define properly the scope of works such as underground works with poor or no geological studies.

In this kind of contract, it is very important to have a common understanding regarding the accounting methods to be followed during execution of the project. Many problems and controversies can be avoided by working out in advance the details of record keeping, purchasing and reimbursement procedures.

The advantages of cost plus percentage of cost contract are:

a) The contractor executes works to the best interest of the owner resulting in good quality of works.

b) The project can commence as early as possible even before detailed drawings and specifications are finalized.

c) Changes in design and method of constructions, if required, can easily be carried out by the contractor without disputes.

d) The progress of works can be speed up to the maximum possible shortening the overall completion time of the project.

Disadvantages of cost plus percentage of cost contract are:

1) The total cost of the project is unknown until completion of the project putting the owner in financial difficulties.

2) It encourages the contractor to increase the actual direct costs of the project unnecessarily as the contractor's profit increases with the increment of these costs.

In the cost plus percentage of cost contract, the contractor shall focus mainly on identification of company head office overhead costs, site overhead costs and relevant income tax laws as well as anticipated profit. Moreover, it is also very important to estimate the total scope of work, which is very important in fixing the percentage of cost.

2-2-10 – COST PLUS FIXED FEE CONTRACT

One of the major shortcomings of the cost plus percentage of cost contract is the tendency of the contractor to increase the cost of the project and cost plus fixed fee contract discourages this tendency of the contractor. In this case, the contract is based on actual direct costs plus fixed fee and the amount of fixed fee covers the overhead costs, profit and income tax of the contractor.

However, cost plus fixed fee contract has also the following disadvantages as compared to the cost plus percentage of cost contract:

a) The scope of works shall be properly defined in advance to reach an agreement on the fixed fee with the contractor.

b) Claims and disputes may occur when major changes are required by the owner during execution of the project.

c) The contractor will insist higher fixed fee depending on the clarity of the defined scope of works.

In this type of contract, the contractor has to be very careful in identifying all other anticipated costs other than the direct costs to fix the amount of fixed fee. Moreover, the time for completion of the project has to be predicted based on the defined scope of works as most of overhead costs are time related costs to the contractor.

2-2-11 – COST PLUS PERCENTAGE OF COST WITH GUARANTEED MAXIMUM COST CONTRACT

The other major shortcoming of the cost plus percentage of cost contract is the owner doesn't know the total cost of the project before its completion. In this regard, the cost plus percentage of cost with guaranteed maximum cost contract resolves this problem in such a way the contract is based cost plus percentage of cost contract but a fixed maximum cost of the project is agreed upon.

If the cost of the project exceeds the guaranteed maximum cost, the contractor absorbs these excess costs. In this way, a ceiling project price is established, in which the owner is assured that this ceiling project cost will not be exceeded. This type of contract has similar disadvantages as that of cost plus fixed fee contract as compared to the cost plus percentage of cost contract except the contractor will insist for higher guaranteed maximum cost instead of higher fixed fee.

2-2-12 – COST PLUS FIXED FEE WITH GUARANTEED MAXIMUM COST CONTRACT

The cost plus fixed fee with guaranteed maximum cost contract resolves the two main shortcomings of the cost plus percentage of cost contract in such a way the contract is based on the actual cost of the project plus fixed fee as well as the maximum cost of the project is also agreed whereby if the actual cost of the project exceeds the maximum guaranteed cost, the contractor absorbs these excess costs.

However, similar with that of the cost plus fixed fee and the cost plus percentage of cost with guaranteed maximum cost contracts, it has the following disadvantages:

a) The scope of work shall be defined in depth where the contractor will be able to predict properly the time required for completion and the total cost of the project.

b) Claims and disputes may occur and usually difficult to settle even when minor changes are required by the owner during execution of the project.

c) The contractor will insist for higher fixed fee and guaranteed maximum costs considering future price escalations as well as clarity of specifications and working drawings.

2-2-13 – TARGET COST INCENTIVE CONTRACT

Even though, the cost plus fixed fee with guaranteed maximum cost resolves the main problems of the owner in the cost plus percentage of cost contract, more risks are transferred to the contractor, which may be reflected through high tender prices. Therefore, the target cost incentive contract is designed to provide an incentive to the contractor to reduce the overall total costs of the project.

The target cost incentive contract is usually applied in combination with the following types of contracts:

- ⇨ Cost plus percentage of cost
- ⇨ Cost plus percentage of cost with guaranteed maximum cost
- ⇨ Cost plus fixed fee with guaranteed maximum cost

In the application of target cost incentive contract, there are different incentive mechanisms such as:

a) Applications of variable percentages of cost depending on the total actual cost of the project with the cost plus percentage of cost contract.

b) Excess cost sharing with the contractor, incase the contractor completed the project less than the guaranteed maximum cost with the Cost plus percentage of cost with guaranteed maximum cost and Cost plus fixed fee with guaranteed maximum cost contracts.

3 – BASIC COST COMPONENTS OF CONSTRUCTION PROJECTS

Basically the cost of any construction project comprises direct costs, which include the direct cost of materials, labor as well as equipments and indirect costs, which include but not limited to head office and site overhead costs.

Therefore, the accuracy of construction cost estimates for a construction project entirely depends on the precision of identifying, quantifying and obtaining commercial and technical data on the direct and indirect costs of the project. Moreover, risk allowance, profit and income tax estimations shall be considered in estimating the total construction cost of a project.

3-1 – DIRECT CONSTRUCTION COSTS

Direct construction costs are all costs that can be specifically booked with an activity in a project. The current trend is to assign as much as possible costs to direct costs as these costs can be budgeted, monitored and controlled far more effectively than the indirect costs. The direct costs mainly include material, labor, equipment and subcontract costs as described below.

a) **Direct material costs** – These costs referring to the cost of materials, consumables and components used for executing an activity including the allowances for scrap and wastages.

b) **Direct labor costs** – All costs related to the workers working on a specific activity such as carpenters, masons, erectors, painters, plumbers and so on.

c) **Direct equipment costs** – These costs referring to the costs of machineries and plants used in executing a specific activity.

d) **Subcontract costs** – In case some specific activities are subcontracted, the subcontract price will be considered as the direct cost of the activities to be executed by the subcontractor.

Some authors include site overhead costs under directs costs with the assumption of these costs are linked directly with a specific project. However, even though these costs are linked with a specific project, they will be shared over many activities within the project. Therefore, site overhead costs are treated under indirect construction costs. Generally, the distinctive nature of direct construction costs is that the total expense can be charged to a specific activity in a specific construction project.

3-2 – INDIRECT CONSTRUCTION COSTS

Indirect construction costs are all costs, which can not be directly booked under a specific activity in a construction project but required to keep the whole project operational. These costs are also called overhead costs, which mainly include the head office and site overhead costs as described below.

3-2-1 - HEAD OFFICE OVERHEAD COSTS

Head office overhead costs are all costs required to run the whole operation of the construction company, which usually administers different projects at a time. These costs are not usually associated with specific project but rather shared proportionally by all projects under the company. Some of the checklists for head office overhead costs are given below with further clarifications.

a) **Senior management costs** – These refer to costs related with salaries and benefit packages of the senior management in the head office.

b) **Indirect labor costs** – Depending on the size, type and organizational structure of the construction company, every organization have to incur costs to cover the salaries and benefits of staffs other than the senior management members working at the head office such as the technical, administrative, marketing, finance and supply staffs.

c) **Head office building costs** – Usually companies either rent or own their office buildings. In both cases, costs are incurred in such a way either rental costs will be paid, if the building is rented and building depreciation will be considered, if the building is owned.

d) **Bidding Expenses** – These costs are usually associated with bid document purchases, site visit expenses, bid bonds and so on. These costs are sometimes called sunk costs.

e) **Expertise service costs** – These costs will be incurred when professional services are required such as the services of external auditors, lawyers, management consultants and external trainings.

f) **Office furniture and equipments** – Different office furniture and equipments are required depending on the size and standard of the company. Some of which are chairs, tables, computers, photocopiers, printers and others facilities depending on the company requirement.

g) **Office running expenses** – The head office operation requires lots of miscellaneous expenses such as telephones, fax, internet services, stationery, mail services and so many others.

h) **Workshops, garages and warehouses** – Depending on the size and type of the construction company, it usually incurs costs related to central workshops, garages and warehouses such as the depreciation costs of the buildings or rental expenses. Moreover, equipment depreciation and running costs shall be considered for the equipments working in the workshops and garages.

i) **Bank charges** – It is very natural that companies may borrow money from banks mainly to purchase machineries, plants, buildings as well as materials. Therefore, the interest to be paid on the borrowed capital shall be considered under the head office costs unless these machineries and plants as well as materials will be consumed in a specific project. In this case, these costs shall be considered under the site overhead costs of the specific project.

j) **Insurance charges** – Depending on the prevailing laws and company internal rules and regulations, usually head office employees have medical insurance. Moreover, the office building and small vehicles shall also be insured and all these insurance charges shall be treated under the head office overhead costs.

k) **Transportation and travel expenses** – The day-to-day activities of the head office require transportation facilities such as small vehicles. Moreover, regular site visits shall be conducted from the head office to the projects sites at different levels to evaluate and assist the proper execution of projects using various means of transportation. In addition, some other local and international visits may be conducted for different purposes such as training, meetings, purchasing, experience sharing, joint venture formation and etc. Therefore, all these costs related to transportation, per diem and living expenses shall be considered under the head office overhead costs.

l) **Sundry expenses** – These are miscellaneous expenses such as advertisement expenses, reception parties and donations.

3-2-2 – SITE OVERHEAD COSTS

Site overhead costs are all costs required to run the whole operation of a specific construction project at site level. These costs are not associated with specific activity in a project but rather shared proportionally by all activities within the project. Some of the site overhead costs are listed below with further clarifications.

a) **Site management costs** – These costs refer to costs related with salaries and benefit packages of the site management members in the project site.

b) **Indirect labor costs** – Depending on the size, type and organizational structure of the construction project, costs are incurred to cover the salaries and benefits of staffs other than the site management members working at the project site such as site engineers, office engineers, administrative and finance staffs, data collectors and so on.

c) **Mobilization and demobilization costs** – Different construction machineries, materials and labor force must be mobilized during construction and all the labor force, remaining machineries and materials shall be demobilized after completing construction of the specific project. These costs are mainly transportation costs.

d) **Tender Expenses** – These costs are related with the costs of the contract performance security, advance repayment guarantee, contractor's all risk insurance, insurance of the works and third party insurance depending on the contract conditions agreed.

e) **Site offices** – Depending on the size and location of the construction project, site offices are constructed from different materials such as corrugated iron sheets, prefabricated materials, material packing steel containers, steel structure and normal hollow concrete blocks.

f) **Expertise service costs** – These costs will be incurred when professional services are required at the project site such as lawyers, claim experts and so on.

g) **Office furniture and equipments** – Different office furniture and equipments are required depending on the size and location of the project. Some of which are chairs, tables, computers, photocopiers, printers and others depending on the project requirement.

h) **Office running expenses** - The site office operation requires different expenses such as telephones, fax, internet service, mail service and stationery.

i) **Radio communications** - If the coverage area of the construction project is vast such as road and hydropower projects, hand held and stationed radio communications may be used within the site and with the head office.

j) **Camp facilities** – In case the project location is far from cities and towns, it is very normal to construct and operate site camps where all staffs and workers will live in. Moreover, the costs of construction and operation of other facilities such as restaurants, recreational centers and playgrounds are also included under the camp facilities.

k) **Access roads** – Depending on the topography and location of the project site, different access roads may be required to construct such as detour roads, access roads to quarry and disposal areas, access roads to facilities such as batching plant, crushing plant and water supply as well as internal temporary roads within the site offices and camp facilities. These costs include the construction and maintenance costs of these access roads.

l) **Water and power supply** – All the site offices, camp facilities, the construction itself requires water and power supply for operating the whole project properly. In case the project location is far from cities and towns, costs will be incurred to construct and operate water and power supplies. These costs may cover the cost of construction, purchase cost of equipments such as generators and water pumps as well as the operation cost of the systems.

m) **Workshops, garages and warehouses** – Depending on the size and type of the project, costs are incurred in constructing and running project workshops, garages and warehouses. Moreover, equipment depreciation and running costs shall be considered for these equipments working in the workshops and garages.

n) **Bank charges** – The construction company may borrow money from banks specifically for a particular project to purchase machineries and plants as well as materials to be consumed in a specific project. In this case, the cost of borrowed capital shall be considered under the site overhead costs.

o) **Transportation and travel expenses** – The site operation requires lots of travels within and outside the project site. Therefore, transportation facilities such as small vehicles are vital for the proper execution of the project. Moreover, depending on the project rules and regulations, some trips may require additional travel expenses such as per diem and displacement allowances.

p) **Insurance charges** – Depending on the prevailing laws and company internal rules and regulations, usually site staffs and workers have medical insurance. It is also very normal that all construction equipments, plants and small vehicles shall be insured.

3-3 – RISK ALLOWANCE

Usually contractors incorporate risk allowances in their tender prices to compensate the negative impacts of different risks such as contractual, technical, political and economic risks.

Contractual risks are usually stemming from the contract agreements with the project owner, subcontractors and suppliers. Consider a lump sum fixed price contract and cost plus percentage of cost contract where the information regarding the project is not adequate. In this particular case, contractors will assume higher risks for the lump sum fixed price contract while lower risks will be considered with the cost plus percentage of cost contract. Moreover, the reputation of project owners, subcontractors and suppliers will be taken into consideration in determining the allowance for contractual risks.

Technical risks are associated usually with the clarification of the technical specifications, working drawings, construction technology and difficulties in understanding new method of constructions.

Political and economic risks reflect the impact of political situations, stability of economic policies, inflation and price escalation on the execution of the intended construction project.

3-4 – PROFIT AND INCOME TAX

Construction projects can be executed by the project owner coordinating his own workforce whereby the issue of profit and income tax can be ignored. However, in most cases, construction projects are executed by contractors whereby these contractors will commit to invest their capital to get maximum possible profit from the contracts to be performed.

However, a profit margin entirely depends on the market competitiveness and company strategies. Moreover, any business company operating a profitable business in Ethiopia is obliged to pay income tax based on the prevailing income tax law.

4 – FUNDAMENTAL APPROACHES TO CONSTRUCTION COST ESTIMATION

The main objective of contractors is to perform construction contracts, which will generate maximum possible profit to their respective business companies. However, in most cases, contractors obtain construction contracts based on tight financial and technical competitions with many other similar construction companies. Therefore, contractors' construction cost estimates shall be competent in order to get the intended project and at the same time these estimates shall be accurate enough in order to keep the profitability of the construction company.

Efficient construction cost estimates shall address properly the required project quality, time for completion of works and of course the construction cost of the project. Competent construction cost estimation usually requires skilled manpower, reliable data and sufficient time. Therefore, contractors need to decide in advance, before wasting their time of such skilled workforce, whether to participate in the intended tender or not. In deciding to participate in the intended project tender, the contractor shall carefully assess the impact of the following key factors:

- ✓ Type of project
- ✓ Method of tendering
- ✓ Type of construction contract
- ✓ Number and progress of contracts already at hand
- ✓ Resource availability i.e. skilled manpower, plants and machineries
- ✓ Financial position

Once decision is made to participate in the intended tender, the contractor shall give due attention to the following major items listed below and prepare checklists of activities under each item, which may affect the quality, time for completion and cost of the construction works.

- ⇨ General and particular conditions of contract contained in the bidding documents
- ⇨ Technical specifications
- ⇨ Drawings
- ⇨ Estimated bill of quantities
- ⇨ Method of measurement
- ⇨ Supporting documents such as information regarding geological formations and hydrological data
- ⇨ Site visits
- ⇨ Construction method statements

Contractors with better understanding of all the above technical and contractual issues are usually in a better position to produce competent tender prices, which can properly address the expected project quality of works, time for completion and reasonable construction costs.

4-1 – GENERAL AND PARTICULAR CONDITIONS OF CONTRACT

A construction contract is defined as an agreement between the owner and the contractor, which is enforceable by law. General and particular conditions of contract basically specify the obligations and responsibilities of the contractor as well as the owner whereby both parties are legally bound to the contract based on these conditions of contract.

General conditions of contract are usually standard conditions of contract such as the FIDIC conditions of contract whereby these conditions are acceptable by many different owners all over the world. However, if such standard conditions of contract is used as general conditions of the contract, some of its clauses has to be modified, deleted or added in the particular conditions of contract to meet the specific requirements of the project owner.

Proper understanding of the general and particular conditions of contract is mainly important for construction cost estimation in identifying the responsibilities and cost implications on the project for various work items where some of them are listed and described below:

A - Amount and type of performance security:

Performance securities can be conditional or unconditional performance securities. Conditional performance securities can be easily obtained from insurance companies with lower premium rates.

However, unlike the conditional ones, unconditional performance securities are usually obtained from banks with higher premium rates and there are also instances where banks are not willing to accept construction machineries as collaterals.

B - Amount of advance payment and type of advance repayment guarantee:

Advance payments are very important whereby it serves the contractor as a start up capital to execute the project. The type of advance repayment guarantee can also be conditional or unconditional advance repayment guarantees, which are similar as that of the performance securities. Moreover, the schedule of advance repayment is also very important for the contractor's cash flow schedule.

C - Time for commencement of the project:

Time for commencement of the project usually helps to define the mobilization schedules, mobilization constraints such as rain season and the like.

D - Time for completion of the whole project:

The completion time is vital in cost estimation in determining the time related head office and site overhead costs. It also helps in determining the risk of price escalation during the execution of the project.

The completion time also helps in determining the method of construction to be adapted to complete the project on time whereby the method of construction directly affects the construction cost of the project.

E - Limit of liquidated damages:

There are instances where the contractor is forced to include liquidate damage risks, if the given completion time is too short for the contractor to deliver the project as defined in the bidding documents.

Therefore, it is always important to check the limit of liquidated damages contained in the bidding documents in relation to the given project completion time for the whole of the works.

F - Retention money:

The percentage and limit of retention money is very important as it affects the project cash flow in executing the project. The contractor shall check both for the amount of retention money and if there are possibilities of collecting this retention money providing bank or insurance securities.

G - Interim and final payments:

The timetable stated for interim and final payments is very crucial in that it completely affects the contractor's project cash flow. Moreover, contractors shall also properly check provisions for interest on delayed payments.

If the tender involves different foreign currencies, it is very important to specify the correct rate of exchange as required in the bidding documents. Errors in fixing rate of exchange may bring irrecoverable enormous losses to the contractor during periods of high inflation.

H - Claims and disputes settlement:

The contractor shall give due attention to the claims and disputes settlement procedures as it usually takes irrecoverable time and money.

It is also important to give special emphasis to the arbitrator indicated in the bidding documents. It could be risky for contractors, if the owner is involved in one way or the other way in the process of dispute resolutions.

I - Price escalation:

If price escalation clauses are included in the conditions of contract, contractors need not to include risks for price escalation for labor, material and equipment included in these conditions of contract in his cost estimates.

However, in the absence of price escalation clauses, the contractor shall include some allowances for price escalation in his cost estimates for construction materials, labor as well as equipments.

J - Tax exemptions:

In countries like Ethiopia for most public and governmental projects, there are usually some form of tax exemptions where contractors may be allowed to import duty free construction materials, machineries and plants which will be exclusively used in the intended project.

Therefore, during construction cost estimation, contractors shall investigate tax exemption clauses usually under the particular conditions of contract. One can easily imagine the cost estimation difference between contractors with proper understanding of tax exemption clauses and contractors without understanding or referring to such important clauses.

K - Insurance of the works:

Owners usually include provisions to insure the works at the cost of the contractor. In such cases, contractors shall properly understand the relevant clauses and incorporate the respective costs in their cost estimates of the project.

However, if the bidding documents indicate that the insurance of the works will be covered by the project owner, there no need for the contractor to incorporate such big costs in his offer.

L - Owner's risks:

The contractor shall thoroughly understand the specified project owner's risks in the conditions of contract such as damages due to war, invasion, incorrect designs, forces of nature and the like. The contractor shall consider the cost implications of such risks depending on the provisions contained in the conditions of contract.

M - Applicable laws:

Applicable laws are very important in cost estimation in such a way the contractor shall refer to all relevant laws in fixing tender prices such as income tax laws, labor laws, import and export laws, rules of arbitration, commercial laws and so on.

Generally, the above items indicate the importance of having a clear understanding of the general and particular conditions of contract in construction cost estimations. Therefore, contractors are advised to understand thoroughly the general and particular conditions of contract before the start of quantifying construction costs of a project.

4-2 – TECHNICAL SPECIFICATIONS

Technical specifications are also called technical provisions. Technical specifications fully describe and define the requirements of the project in conjunction with drawings in which specifications mainly provide information which can not be shown on drawings or too lengthy to define on drawings.

Technical specifications specify the following crucial information to the contractor and it is the sole basis both for the construction methods to be adapted and the construction cost of the project.

- ✓ Quality of materials
- ✓ Quality of machineries and plants
- ✓ Quality of workmanship
- ✓ Erection and installation methods
- ✓ Test and inspection requirements and methods

Technical specifications basically have restricted applications, which usually define specific work items. Therefore, for a better understanding and cost estimation of the project, the contractor must check the given specifications for:

- ✓ Technical accuracy and adequacy
- ✓ Define and clear stipulations
- ✓ Fair and equitable requirements

- ✓ Formats which can be easily used during bidding and construction
- ✓ Legal enforceability

Generally, there are different specifications such as the performance specifications, design specifications, open specifications, closed specifications, proprietary specifications and equal specifications as described below. Therefore, the contractor shall give due attention to the type of specification dealing with as it determines the freedom of selecting different construction methods.

4-2-1 – PERFORMANCE SPECIFICATIONS

Performance specifications mainly state how the finished product must perform during operation. Performance specifications neither specify specific materials to be used nor dictate the contractor how to execute the works as demonstrated with the following example.

- ⇨ *All concrete works shall have 28 days strength of 25MPa characteristic compressive strength.*

In the above sample of performance specification, the contractor is free to select type and quantities of cement, coarse aggregate, fine aggregate, methods of mixing, transportation, placing, vibration and curing of concrete works. However, the contractor is responsible for 28days strength of the concrete works, which is a minimum of 25MPa characteristic compressive strength.

4-2-2 – DESIGN SPECIFICATIONS:

Design specifications are also known as the materials and workmanship specifications or perspective specifications. Design specifications mainly state the overall method of construction as demonstrated in the example below.

- ⇨ *For all concrete works, use ordinary Portland cement with minimum cement content of 360kg/m^3, water content 50lt/m^3, mojo sand 0.5m^3/m^3 and basaltic coarse aggregate of 20mm size 0.75m^3/m^3. Moreover, all ingredients shall be mixed for 3 minutes using 500ltr mechanical mixer and it has to be transported and placed using 20ton mobile crane as well as 30mm diameter vibrators shall be used for vibration.*

In this type of specification, the contractor has no freedom to select type and quantity of materials, method of construction and required equipments. Therefore, all the type and quantity of materials as well as equipments specified shall be used during cost estimation and construction of the project.

In design specification, the owner is responsible for the performance of the work during operation. In this particular example, the owner is responsible for the strength and durability of the concrete works.

4-2-3 – OPEN SPECIFICATIONS

Open specifications usually state the quality of materials to be used in construction. As its name indicates in such kind of specifications, the contractor is allowed to use any product, which meets the specified requirement as demonstrated with the following sample specification.

⇨ *Use ordinary Portland cement for all concrete works.*

In this case, the contractor has the freedom to select different ordinary Portland cement from different suppliers based on cost or any other merits such as credit facilities during cost estimation of the works.

4-2-4 – CLOSED SPECIFICATIONS

Closed specifications also state the quality of products to be used during construction but only restricted number of products are allowed as demonstrated in the following example.

⇨ *Use only Muger or Messobo ordinary Portland cement for all concrete works.*

As stated in the sample specification, the contractor can only use ordinary Portland cement produced either in Muger or Messobo but not from any other supplier. Therefore, the contractor shall consider this constraint during cost estimation for concrete works.

4-2-5 – PROPRIETARY SPECIFICATIONS

Proprietary specifications allow only one type of product to be used in the construction of a specific item of work as demonstrated below.

⇨ *Use only Messobo ordinary Portland cement for all concrete works.*

In this case, the contractor has no any other option to consider except Messobo ordinary Portland cement in estimating the cost of concrete works.

4-2-6 – EQUAL SPECIFICATIONS

Equal specifications normally specify one type of product to be used in the construction of a specific work item but it also allows the usage of other products that are ''equal'' or better in quality as demonstrated with the following example.

⇨ *Use Messobo ordinary Portland cement or from any other sources with equal standards for all concrete works.*

When the owner uses equal specifications, the contractor has different options as far as all these options have equal standard or better as that of the specified product. In this particular sample specification, the contractor can assess different suppliers of cement with equal or better production standards as compared to Messobo ordinary Portland cement.

4-3 – DRAWINGS

Drawings are the means by which the owner conveys physical, quantitative and visual descriptions of the intended project to the contractor. Assume a building project whereby the owner conveys all related information in conjunction with the technical specifications to the contractor through architectural, structural, sanitary, electrical and HVAC drawings.

The contractor mainly understands from the drawings what type of construction methods to be adapted during cost estimation as well as construction of the project. As an example, if a high rise building is shown in the drawings, the contractor shall check all possible options to select the appropriate method of construction based on the building height, size, available resources, existing facilities near the building, access as well as topographical conditions. In this case, some of the construction methods which need to be addressed during cost estimation of this building project are:

- ✓ Concrete production
- ✓ Concrete transportation and placement
- ✓ Transportation of construction materials to different floors
- ✓ Methods and type of scaffolding
- ✓ Types and methods of shuttering works
- ✓ Erection and installation of glazing works
- ✓ Temporary access for manpower working at different floors
- ✓ Skilled manpower requirement
- ✓ And so on.

There are different construction methods to resolve all the above issues incurring different construction costs depending on the construction method selected. Therefore, it is entirely up to the contractor to select cost effective construction method both during cost estimation and construction of the project.

4-4 – ESTIMATED BILL OF QUANTITIES

In unit rate contracts, the owner usually provides the estimated bill of quantities of the project with the bidding documents. The contractor shall generally check the given volume of works based on the drawings as well as site visit information. In some cases due to intentional and unintentional mistakes, the estimated quantities of works can be misleading which can cause enormous loss to the contractor in selecting and purchasing wrong resources both during the cost estimation and execution of the project.

These estimated quantities of work are also the basis to determine the type and number of resources to be deployed during construction of the project. Moreover, construction methods shall be selected in such a way the given quantity of works can be executed during the completion time of the project.

Based on the estimated quantity of works, the contractor shall decide the method of construction to be adapted during executing of the project such as:

- ✓ Type and size of crushing plants
- ✓ Type and size of mechanical mixers or batching plants
- ✓ Type, size and number of machineries such as dozers, graders, loaders, rollers, dump trucks and so on.
- ✓ Skill and number of manpower requirement
- ✓ Type and quantity of construction materials
- ✓ And so on

4-5 – SUPPORTING DOCUMENTS

Supporting documents such as geological formations, hydrological data and other technical reports like socio-economic studies are usually provided by the owner to contractors for their own interpretations for heavy construction projects.

Therefore, the contractor shall have the technical ability and experience in interpreting the technical data provided to determine construction methods to be adapted which directly affects the construction cost estimates.

4-6 – SITE VISITS

In order to prepare competent and reasonable construction cost estimates, the contractor must visit the project site unless the site is familiar to the contractor with previous reliable site information. Site visits are critically important especially when the contractor is working with heavy construction project cost estimates such as road works and hydropower projects.

The contractor shall prepare his own checklists during the site visit which shall address, but not limited to, the following issues which have direct impact on the construction costs of the intended project.

A – Location of the site:

- ✓ It helps to determine the mobilization and demobilization costs.
- ✓ It also helps to determine the transportation cost of materials from main material suppliers.
- ✓ Availability and expected wages of daily labors can be fairly estimated based on the location of the site.

- ✓ Site location also helps to determine the type of camp facilities required to be constructed such as project offices, living areas, food accommodations and so on.
- ✓ Having proper understanding of site location and local weather condition helps the contractor to determine salaries and benefits of staffs, skilled manpower and daily laborers.

B – Location of local construction materials:

- ✓ The contractor shall identify the location and quality of local construction materials such as quarry area for gravel production, sand, selected material, water as well as sub base and base course materials in the case of road projects.
- ✓ Moreover, the contractor shall have the general understanding of the site layout for different plants such as batching and crushing plants.

C – Access roads:

- ✓ Site access roads to the main works, quarry areas, water supply, sand, and the like shall be identified which incurs additional construction and maintenance costs. These costs are extremely high, incase of heavy construction sites such as road works, hydropower projects and so on.
- ✓ The contractor shall also check the road conditions and bridges leading to the project site.

D – Water and power supply:

- ✓ The source of water and power supply both to the manpower at site and the works shall be properly designed based on the site conditions.
- ✓ Moreover, overall requirements of water treatment plants, pumps and generators shall be identified with especial emphasis when projects are located at remote areas.

E – Communication facilities:

- ✓ Based on the location and size of the project, the contractor shall have sufficient understandings of the cost estimates to install communication facilities such as telephones, faxes, internet services, and radio communications which will help to facilitate the overall operations of the project.

F – Environmental protection:

- ✓ Environmental issues are becoming global issues where the contractor shall properly check the contract and site conditions and design appropriate environmental protection methods such as watering to dusty roads, proper drainage and earthworks to quarry areas after completion of works and so on.

G – Existing facilities:

- ✓ If the project site is located in a city or town, it is very usual that there can be different facilities such as telephone, water, sewerage and power lines. Therefore, the contractor shall properly investigate the existing facilities and related relocation or replacement costs.

It is clearly shown that all of the above site visit related information have a direct impact on the construction cost estimation of a project. Therefore, contractors are advised to conduct site visits and satisfy themselves with all the data collected from the project sites during construction cost estimation of projects.

Unless proper site visits are conducted during construction cost estimation, contractors are simply ‘’walking in darkness’’ without knowing the proper cost track of the intended project.

4-7 – METHOD OF MEASUREMENT

Contractors shall thoroughly understand the method of measurement incorporated within the bidding documents before starting any cost breakdown calculations. Method of measurement indicates how the executed works will be measured for payment during performance of the contract. Therefore, contractors must be sure that their tender unit prices cover all costs of all relevant work items and volume of works per unit of measure based on the method of measurement.

Method of measurements may vary from project to project based on the convenience to the project owner. Moreover, different institutions have prepared standard method of measurements such as the Civil Engineering Standard Method of Measurement (CESMM) developed by the Institution of Civil Engineers in the United Kingdom.

In Ethiopia, there are basically two method of measurements prepared by local governmental and private institutions i.e. the ERA standard specifications prepared by the Ethiopian Roads Authority and the BaTCoDA technical specification and method of measurement prepared by SB Consult and reviewed by a committee of professionals from Addis Ababa University and BaTCoDA.

In order to see the importance of understanding method of measurement for the purpose of construction cost estimation, let's demonstrate how cast in situ concrete work is measured using the following method of measurements.

- ⇨ BaTCoDA Technical specification and method of measurement [21]
- ⇨ ERA standard specifications [22]
- ⇨ Civil Engineering Standard Method of Measurement (CESMM) [6]

In order to have common understanding of the subject matter, cast in situ concrete is defined as concrete premixed at a batching plant and transported to the work site or concrete ingredients are transported to the site and mixed just before casting in place.

A – BaTCoDA Technical Specification and Method of Measurement:

According to BaTCoDA technical specification and method of measurement, cast in situ concrete works include provision of cement, aggregate, water, admixture, labor, equipment and tools for the satisfactory installation of the works. Moreover, cast in situ concrete includes batching, mixing, casting in place, construction joints, tamping of horizontal surfaces and curing.

Cast in situ concrete shall be measured by volume except for the following:

- → Ribbed slabs measured by area stating thickness
- → Grouting and filling to holes shall be enumerated stating sizes

In calculating the volume of cast in situ concrete, no deduction shall be made for voids up to 0.25m^2 in area.

Therefore, if a contractor is bidding with BaTCoDA technical specification and method of measurement, his direct unit costs for cast in situ concrete shall include the following costs:

- ⇨ *Material costs: Cement, Aggregates, Water and Admixtures*
- ⇨ *Labor costs: Batching, Mixing, Transporting, Placing, Tamping and Curing*
- ⇨ *Equipment cots: Batching, Mixing, Transporting, Placing, Tamping and curing*
- ⇨ *The material, labor and equipment costs of construction joint preparations, if concrete is to be placed on hardened concrete*

Moreover, the contractor shall also consider for wastages and excess volume of works, which are not payable based on the method of measurement such as excess concrete works in underground tunnel linings due to over excavation, which can be minimized but not avoided.

B – ERA Standard Specifications:

ERA Standard Specifications measures cast in situ concrete in cubic meters for each class of concrete. In computing the volume of concrete for payment, the dimensions used shall be those shown on the plans or ordered in writing by the Engineer, but the measurement shall not include any concrete used in the construction of cofferdams or falsework. Moreover, the measurement shall not include forms or falsework as well as any increased cement content, admixtures and concrete finishing.

In calculating the volume of concrete, no deductions shall be made for the volumes of reinforcing steel, drainage holes, weep holes, timber bumpers, pipes and conduits less than 30cm in diameter or pile heads embedded in concrete.

In accordance with the ERA standard specifications, the unit direct cost of cast in situ concrete includes the following costs:

- ⇨ *Material costs: Cement, Aggregates, Water and Admixtures*
- ⇨ *Labor costs: Batching, Mixing, Transporting, Placing, Tamping and Curing*
- ⇨ *Equipment cots: Batching, Mixing, Transporting, Placing, Tamping and curing*

Moreover, the material, labor and equipment costs of the following items shall be included in the unit direct costs of cast in situ concrete:

- ⇨ *Erection and removal of falseworks*
- ⇨ *Construction joint preparations*
- ⇨ *Installation of expansion joints*
- ⇨ *Concrete finishing works*
- ⇨ *Cofferdam works*

Let's demonstrate on how to incorporate these additional costs such as the cost of falseworks to the unit cost of cast in situ concrete works. The contractor shall quantify the volume of cast in situ concrete and all additional works which are not payable based on the method of measurement for every concrete structure.

In order to simplify the demonstration, assume the following estimated quantity of works for a small concrete structure.

- ⇨ *Cast in situ concrete……....240m^3*
- ⇨ *Falsework……..120m^2*
- ⇨ *Stone masonry cofferdam……...24m^3*
- ⇨ *Construction joint……..4m^2*
- ⇨ *Expansion joint……..3m^2*

Based on the given estimated data and the ERA standard specifications, the direct unit cost per cubic meter of cast in situ concrete includes the following costs:

- ⇨ *Cast in situ concrete ……..……..……..…....1m^3*

- ⇨ *False work (120/240) ……..……..0.5m²*
- ⇨ *Stone masonry cofferdam (24/240)…..…..……0.1m³*
- ⇨ *Construction joint (4/240)……0.017m²*
- ⇨ *Expansion joint (3/240)……0.013m²*

C – Civil Engineering Standard Method of Measurement (CESMM):

In the Civil Engineering Standard Method of Measurement, cast in situ concrete works are separated into two entirely different payable items i.e. Provision of concrete and Placing of concrete both measured in cubic meter.

In this case, the contractor will find two separate items for cast in situ concrete works which are the provision of concrete and placing of concrete in the estimated bill of quantities. Therefore, during the direct cost estimations, the contractor shall consider the following costs for each item separately.

For provision of concrete:

- ⇨ *Material costs: Cement, Aggregates, Water and Admixtures*
- ⇨ *Labor costs: Batching, Mixing and Transporting*
- ⇨ *Equipment cots: Batching, Mixing and Transporting*

For placing of concrete:

- ⇨ *Labor costs: Placing, Tamping and Curing*
- ⇨ *Equipment cots: Placing, Tamping and Curing*

According to the Civil Engineering Standard Method of Measurement, there is separate payable item for the preparation of construction joints. Therefore, contractors shall not include the cost of construction joint preparations in the direct unit costs for provision of concrete or placing of concrete.

4-8 – CONSTRUCTION METHOD STATEMENTS

After having clear understanding of the project specifications, method of measurement, supporting documents, site visits, estimated bill of quantities, drawings, general and particular conditions of contract, the next crucial step in the process of construction cost estimation is the preparation of construction method statements.

Construction method statements give the clear picture of each project activity execution during the construction phase of the project. The required quality of works as per the specifications, estimated quantity of works, safety standards, as well as time for completion are the sole basis in determining the construction method statements of a project. Construction method statements shall clearly indicate the following crucial construction issues:

- → Skill and number of manpower required
- → Type and specification of equipments required
- → Quantity and quality of materials required
- → Proposed working crews
- → Estimated crew productivity
- → Estimated duration for completion
- → Expected defects and remedial measures

Generally, there are possibly many alternatives in the preparation of a construction method statement to execute a particular activity in a project. However, as contractors usually obtain projects mainly based on price competition, the less costly construction method statement, which can satisfy the specified quality of works and safety issues as well as the time for completion of the project, shall be considered both during cost estimation and execution of the project.

4-8-1 – SKILL AND NUMBER OF MANPOWER

Before deciding the type, skill and number of manpower required, it is better to understand the type and quality of works specified in the bidding documents. There are also instances whereby the specification specifies the required experience for the execution of some specific activities. As an example, an extract of a specification for drilling and grouting is taken from Tekeze Hydropower project as read below:

- ⇨ *"The Contractor shall satisfy the Engineer that he is experienced in drilling and grouting, that he has previously successfully carried out similar work of comparable magnitude and that he possesses the necessary equipment and skilled staff. Otherwise, the contractor shall employ an experienced specialist sub-contractor to carry out the drilling and grouting work. The Contractor shall provide an engineer with not less than fifteen years experience in drilling and grouting to supervise the work, together with foremen with not less than ten years similar experience."* [19]

Generally, there are two basic sources to obtain the appropriate experience and number of required manpower to execute particular activity in a construction project, i.e. the internal and external sources. Internal sources are direct employees of the contractor while external sources can be obtained from the local market or international market depending on the required skill and experience.

4-8-2 – TYPE AND SPECIFICATION OF EQUIPMENTS

Equipment selection is one of the major decisions to be made by the contractor in the preparation of construction method statements. Equipments required for the execution of a particular construction activity can be obtained from a pool of owned equipments or it can be rented from leasing companies or purchased from

either local or international market. Generally, the type and specification of equipments to be selected in the construction method statements depend on many factors such as:

- ✓ Type and volume of works to be performed
- ✓ Cost and maintainability of the equipment
- ✓ Operating costs
- ✓ Performance of the equipment
- ✓ Age of the equipment
- ✓ Availability and skill of operators
- ✓ Weather conditions
- ✓ Working space limitations
- ✓ Mobility of equipment required
- ✓ Availability of spare parts
- ✓ Type and specification of owned equipments
- ✓ Equipment rental rates, if to be rented
- ✓ And so on

Moreover, there are also cases whereby the required equipments are specifically specified in the technical specifications where the room to select different sizes of equipments is restricted. As an illustration, an extract of a specification for concrete batching plant is taken from Tekeze Hydropower project as read below:

- ⇨ *"The contractor shall provide at least two separate concrete batching plants with an effective total capacity of at least 300 cubic meters per hour for the arch dam and a 50 cubic meter per hour plant for other concrete works. The equipment shall be suitable for weighing out, for any particular batch of concrete, up to six different nominal classes of aggregate, two varieties of cement, water and admixture such as air entraining agents or plasticizers and it may have to be fitted with ice bin. Apparatus shall be included to record automatically, with an accuracy of ± 1 percent, the weight of cement used in the production of concrete."* [19]

4-8-3 – QUANTITY AND QUALITY OF MATERIALS

In establishing the construction method of statement, the quantity and quality of materials shall be clearly identified based on the estimated bill of quantities, method of measurement, technical specifications, drawings, site visits as well as related technical investigations such as geological formations.

The technical specification is actually the core issue in deciding the quality of materials to be considered during the cost estimation and execution of the particular activity. Therefore, especial emphasis shall be given to the type of specification whether it is performance, design, open, closed, proprietary or equal specifications.

The other important factor in calculating the required quantity of materials to execute a unit volume of an activity is the method of measurement adapted. Moreover, additional quantities of materials shall be considered for wastage depending on the contractor's experience, manufacturers' recommendations or results of trial tests.

In dealing with earthworks, especial care shall be taken in converting the bank, loose and compacted volumes to one another. In this case, it is very important to note the following volume converting formulas in calculating the required volume of earthworks to be executed.

- **Bank Volume = Loose Volume x Swell Factor……(1)**
- **Bank Volume = Compacted Volume x Shrinkage Factor……..(2)**

Where:

- Swell Factor = 1/(1+Swell)……(3)
- Shrinkage Factor = 1/(1-Shrinkage)……(4)

And

- Swell (%) = ((Loose Volume – Bank Volume)/Bank Volume) **x** 100…….(5)
- Shrinkage (%) = ((Bank Volume – Compacted Volume)/Bank Volume) **x** 100…..…(6)

4-8-4 – PROPOSED WORKING CREWS

Once the required manpower, equipments and materials are identified, the next step is to establish working crews. Working crews are working teams composed of appropriate manpower and equipments which can execute the particular activity to the satisfaction of the bidding documents. Proposed working crews can be formulated based on previous experience of similar works, national and international performance standards as well as actual results from trial tests.

4-8-5 – ESTIMATED CREW PRODUCTIVITY

Estimated crew productivity is the crew output per unit time usually per hour or working day. Crew productivity is very crucial in cost estimation as it automatically results the crew cost to execute a unit volume of particular activity. It is usually very difficult to get accurate estimates of crew productivity unless proper databases are developed based on previous work experiences of similar size, nature and complexity. Generally, estimated crew productivity can be obtained from the following sources:

- ✓ Organizational records of previous projects
- ✓ Project team knowledge and experience

- ✓ National and international performance standards
- ✓ Commercially available database
- ✓ Expert advice
- ✓ Field research
- ✓ Manufacturers' recommendations

In Ethiopia, even though there are no as such reliable data collections and researches, there are basically three proposed performance standards developed by different governmental institutions.

- ⇨ Construction Performance Standard developed by the Ethiopian Transport Construction Authority [15]
- ⇨ EBCA Performance data developed by the Ethiopian Building Construction Authority [14]
- ⇨ EBCS 14: Building Construction output Standards in Ethiopia developed by the Ministry of Works and Urban Development [16]

4-8-6 – ESTIMATED DURATION FOR COMPLETION

It is very important to check if the estimated crew productivity and number of crews assumed in the construction method statement can execute the over all project activities within the expected project milestones and overall project duration. Therefore, contractors shall thoroughly check that their construction method statements will enable to complete the overall project within the given time schedule.

- ⇨ Expected duration = Volume of works/(Number of Crews x Crew Productivity)

4-8-7 – EXPECTED DEFECTS AND REMEDIAL MEASURES

Last but not least, in the process of preparing a construction method statement, it is very crucial to identify what defects may result as a result of implementing the proposed construction method statement and what kinds appropriate remedial measures has to be taken.

Consider a concrete water tank structure whereby the formwork method statement proposes the usage of bolts in fixing the formwork on both sides of the concrete faces. In this particular case, careful remedial measures shall be considered to fill the bolt positions such as using non-shrinkage cement after formwork removal to keep the concrete water tank structure watertight. Therefore, all these costs of remedial measures have to be considered in the process of cost estimation for this particular type of formwork.

5 – COSTRUCTION COST ESTIMATION FORMATS

After having a clear picture of every activity in a construction project and appropriate construction method statements are prepared to execute these activities to the satisfaction of the bidding documents, a contractor shall extract the required resources to execute each activity based on his construction method statements. These resources are the detail-required breakdowns of materials, labor and equipments to execute each activity.

Once the required resource breakdowns are identified, the next step is to estimate the construction cost for each activity and the project as a whole. As discussed under chapter 3, these construction costs are classified into two broad categories i.e. the direct and indirect costs. Direct construction costs are all costs that can be specifically identified with a particular activity in a project and these costs are:

- Direct material costs
- Direct labor costs
- Direct equipment costs

On the other hand, indirect construction costs are all costs, which cannot be directly booked under a specific activity in a construction project but required to keep the whole project operational. These costs are also called overhead costs, which mainly include:

- Site overhead costs
- Head office overhead costs

Moreover, contractors may also incorporate risk allowances in their tender prices to compensate the negative economic impacts of mainly price escalation of construction materials, labor and equipments. Unless otherwise established for special purpose, contractors perform construction contracts to get maximum possible profit and any construction company operating a profitable business in Ethiopia shall pay 30% of its gross profit as an income tax as per the income tax proclamation No. 286/2002. [41]

Moreover, if the contractor is registered for VAT, which is usually the case, the contractor's construction cost estimate shall also include Value Added Tax which is 15% of the tender amount in accordance with the Value Added Tax proclamation No. 285/2002.[38] In case a contractor fails to include Value Added Tax in his tender price, the contractor is obliged to pay the Value Added Tax to the Federal Inland Revenue Authority from his own.

However, if the contractor is not registered for VAT, the construction cost estimates shall include Turnover tax, which is 2% of the tender amount in accordance with the Turnover Tax Proclamation No. 308/2002.[39]

Therefore, in the process of construction cost estimation, in addition to the direct and indirect costs, a contractor shall also give due attention to:

- Risk allowances
- Profit and income tax
- Value Added Tax
- Turnover tax

As discussed earlier, construction cost estimation techniques may vary from organization to organization involving different varieties of data, formats and costing procedures and each cost estimator may also add his/her own art in the preparation of these construction cost estimates of a specific project.

Therefore, it is advisable that contractors shall adapt suitable construction cost estimation formats which enables to see all the detailed cost breakdowns of the required direct materials, labor and equipment as well as the head office and site overhead costs, risk allowances, profit, income tax and Value Added Tax or Turnover tax.

Moreover, these construction cost estimation formats and procedures shall also serve as the basis for different purposes as listed below in managing the project during construction.

- ✓ Construction planning
- ✓ Project cash flow preparation
- ✓ Productivity data collection
- ✓ Material consumption data collection
- ✓ Construction monitoring
- ✓ Performance evaluation and controlling
- ✓ Performance related pay
- ✓ Subcontractor's price evaluation
- ✓ Variations and claims substantiation
- ✓ Remedial measures and improvements

As a result, different construction cost estimating formats of different local and international contractors have been assessed as well as discussions have been held with different professionals working with these local and international contractors and one major governmental consulting firm to develop a sample construction cost estimation format as shown in Format 5-1A and 5-1B. Format 5-1A is prepared for VAT registered contractors while Format 5-1B is prepared for small contractors not registered for VAT.

FORMAT 5-1A - CONSTRUCTION COST ESTIMATION PRICE ANALAYSIS SHEET

PROJECT NAME	
BOQ REFERENCE	
ACTIVITY CODE	
UNIT OF MEASURE	

ACTIVITY DESCRIPTION

DIRECT MATERIAL COST					**DIRECT LABOR HOURLY COST**						**DIRECT EQUIPMENT HOURLY COST**				
Material Description	Unit	Quantity	Unit cost	Total cost	Labor by trade	No of labor	Basic salary	Labor index	UF	Total cost	Equipment description	No of equipments	Hourly cost	UF	Total cost
A – TOTAL DIRECT MATERIAL COST					**B - TOTAL DIRECT LABOR HOURLY COST**						**C – TOTAL EQUIPMENT HOURLY COST**				

D – Hourly crew productivity	**Data**
E – Direct material cost	**A**
F – Direct labor cost	**B/D**
G – Direct equipment cost	**C/D**
H – DIRECT UNIT COST	**E + F + G**
I – Site overhead costs	**K1 * H**
J – Head office overhead costs	**K2 * H**
K – INDIRECT UNIT COST	**I + J**

L – RISK ALLOWANCE	**R1*E + R2*F + R3*G + R4*I +R5*J**
M – GROSS PROFIT	**P%/0.7 * (H + K + L)**
N – TOTAL UNIT PRICE WITHOUT VAT	**H + K + L + M**
O – VALUE ADDED TAX (VAT)	**0.15 * N**
P – TOTAL UNIT PRICE WITH VAT	**N + O**
REMARK	

FORMAT 5-1B - CONSTRUCTION COST ESTIMATION PRICE ANALAYSIS SHEET

PROJECT NAME	
BOQ REFERENCE	
ACTIVITY CODE	
UNIT OF MEASURE	

ACTIVITY DESCRIPTION

DIRECT MATERIAL COST					**DIRECT LABOR HOURLY COST**						**DIRECT EQUIPMENT HOURLY COST**				
Material Description	Unit	Quantity	Unit cost	Total cost	Labor by trade	No of labor	Basic salary	Labor index	UF	Total cost	Equipment description	No of equipments	Hourly cost	UF	Total cost
A – TOTAL DIRECT MATERIAL COST					**B - TOTAL DIRECT LABOR HOURLY COST**						**C – TOTAL EQUIPMENT HOURLY COST**				

D – Hourly crew productivity	**Data**
E – Direct material cost	**A**
F – Direct labor cost	**B/D**
G – Direct equipment cost	**C/D**
H – DIRECT UNIT COST	**E + F + G**
I – Site overhead costs	**K1 * H**
J – Head office overhead costs	**K2 * H**
K – INDIRECT UNIT COST	**I + J**

L – RISK ALLOWANCE	**R1*E + R2*F + R3*G + R4*I +R5*J**
M – GROSS PROFIT	**P%/0.7 * (H + K + L)**
N – TURNOVER TAX	**0.02 * (H + K + L + M)**
O – TOTAL UNIT PRICE	**H + K + L + M + N**
REMARK	

The above two construction cost estimation formats mainly focus on how to develop the construction costs to execute a unit of an activity. Basically, whatever type of construction projects, construction contracts as well as tendering methods are adopted by the project owner, contractors shall develop the unit costs of each activity which is the sole basis to estimate the total project cost.

Even though, the above two proposed construction cost estimation formats are simple and friendly to use, additional clarifications on how to use these construction cost estimation formats are provided below.

I – Direct material cost (E):

Direct material cost is the total cost of construction materials required to execute a unit of specific activity in a project. In estimating the direct material cost, the contractor shall obtain the quantity and quality of materials required to produce the specific unit of an activity from his construction method statements as well as the material unit costs at the construction project site from his suppliers which will be discussed in chapter 6.

- **Direct material cost = $\sum$ (Material quantity * Material unit cost)**

II – Direct labor cost (F):

In calculating the direct labor cost, contractors need to calculate the direct labor hourly cost which is the total hourly cost of labor crew required to execute a specific activity in the project.

In estimating the direct labor hourly cost, the contractor shall obtain the number of labor, skill and labor utilization factor (UF) required to execute a specific activity from his construction method statements as well as the labor basic salary and labor index from his previous records and the labor market.

Labor index is a multiplying factor of the basic salary which represents the additional benefits whereby a worker gets from the contractor such as overtime payments, annual leave pay, severance pay, bonus and other benefits which will be discussed in chapter 7.

Moreover, among the labor crew members there are cases whereby a member may work for two or more labor crews and the utilization factor (UF) for this type of member shall be calculated to indicate his/her contribution in the specific crew.

As an example, if a carpenter foreman is assigned to lead two similar size and task carpenter crews, under normal circumstances this carpenter foreman is expected to spend his working time equally with each crew. Therefore, the utilization factor of the carpenter foreman is 0.5 in each working crew.

- ⇨ **Direct labor hourly cost = $\sum$(No of labor * Basic salary * Labor index * UF)**
- ⇩ **Direct labor cost = Direct labor hourly cost / Hourly crew productivity**

III – Direct equipment cost (G):

In a similar way as that of the direct labor cost calculation, in order to calculate the direct equipment cost, contractors need to calculate the direct equipment hourly cost which is the total hourly cost of equipment crew required to execute a specific activity in a project. In estimating the direct equipment hourly cost, the contractor shall obtain the number of equipments, capacity and equipment utilization factor (UF) required to execute specific activity from his construction method statements as well as the equipment hourly cost.

In calculating the equipment hourly costs during project cost estimation, the contactor may assume to execute the intended project using either owned or rented construction equipments. If owned equipments are assumed, contractors need to calculate the hourly equipment owning costs, operating costs and operator's costs and on the other hand, if rented equipments are assumed, the hourly rental rate of the leasing companies shall be considered. For further references, the equipment hourly cost establishment will be discussed in detail under chapter 8.

Moreover, in cases where specific equipment is assigned to work for two or more working crews, the utilization factor (UF) for this equipment shall be calculated to indicate its contribution in each working crew. As an example, if a handheld compactor is assigned for three similar size backfilling working crews, the utilization factor of this handheld compactor is 0.33 in each crew.

- ⇨ **Direct equipment hourly cost = $\sum$ (No of equipment * Hourly cost * UF)**
- ⇩ **Direct equipment cost = Direct equipment hourly cost / Hourly crew productivity**

Once all the direct material costs, direct labor costs as well as the direct equipment costs are estimated, the total direct unit cost of the specific activity will be calculated as the sum of all these costs.

- ⇩ **Direct unit cost = Direct material cost + Direct labor cost + Direct equipment cost**

IV – Site overhead costs (I):

As discussed in chapter 3, site overhead costs are all costs required to run the whole operation of a specific construction project at site level. These costs are not associated with specific activity in a project but rather shared proportionally by all activities within the project. Therefore, it is easier to express the site overhead costs as a percentage of the direct unit cost of an activity, which will be discussed in detail under chapter 9.

- **Let, K1 = Total site overhead costs / Total project direct costs**
  - **Site overhead costs = K1 * Direct unit cost**

V – Head office overhead costs (J):

Head office overhead costs are all costs required to run the whole operation of the construction company, which usually administers different projects at a time. These costs are not usually associated with specific project but rather shared proportionally by all projects under the company. Therefore, similar as that of the site overhead costs, it is easier to express the head office overhead costs as a percentage of the direct unit cost of an activity, which will be discussed in detail under chapter 9.

- **Let, K2 = Annual head office overhead costs / Average annual direct cost turnover**
  - **Head office overhead costs = K2 * Direct unit cost**

If one calculates both the site overhead costs and the head office overhead costs, the indirect unit cost of an activity is simply the sum of these two overhead costs.

- **Indirect unit cost = Site overhead costs + Head office overhead costs**

VI – Risk allowance (L):

All these estimated direct material, labor and equipment costs as well as the site overhead costs and head office overhead costs may change from time to time mainly due to economic, social, political and technical variations as compared to the assumptions made during the cost estimation which will be discussed in detail under chapter 10.

Referring to the construction cost estimation formats above, let's assume the following factors represent the percentage cost increment of each cost component and the risk allowance will be calculated as follows:

- → R1----------Direct material cost (E)
- → R2----------Direct labor cost (F)
- → R3----------Direct equipment cost (G)
- → R4----------Site overhead costs (I)
- → R5----------Head office overhead costs (J)

- **Risk allowance = R1*E + R2*F + R3*G + R4*I + R5*J**

VII – Gross profit (M):

Unless otherwise established for a special purpose, contractors normally invest their capital to get maximum possible profit from the contracts to be performed. The profit margin depends entirely on the market competitiveness and company strategies. Moreover, any construction company operating a profitable business in Ethiopia shall pay 30% of its gross profit as an income tax as per the Income tax proclamation No. 286/2002. [41]

As an illustration, if the net profit margin is assumed to be **P%** of the breakeven cost (direct costs + indirect costs + risk allowances), the gross profit (net profit + income tax) can be calculated as follows, which is **X%** of the breakeven cost.

- ⇨ Let, **Q** be the breakeven cost
- Gross Profit = X% * Q
- Net Profit = P% * Q
- Income tax = 30% * Gross profit
- Gross Profit = Net Profit + Income tax
- X% * Q = P% * Q + 0.3 * X% * Q
- X% = P% + 0.3 * X%

- **X% = (P/0.7)%**

- **GROSS PROFIT = (P/0.7)% * BREAKEVEN COST**

VIII – Total unit price without VAT:

If the contractor is registered for VAT but the contract is VAT exempted, the contractor's unit price in his tender is the sum of direct unit cost (H), indirect unit cost (K), risk allowance (L) and gross profit (M).

- **TOTAL UNIT PRICE WITHOUT VAT = H + K + L + M**

IX – Total unit price with VAT:

If the contractor is registered for VAT and the contract is not VAT exempted, the contractor's unit price in his tender is the sum of direct unit cost (H), indirect unit cost (K), risk allowance (L) and gross profit (M) plus 15% of this sum based on the Value Added Tax proclamation No. 285/2002.[38]

- **TOTAL UNIT PRICE WITHOUT VAT (N) = H + K + L + M**
- **VALUE ADDED TAX (O) = 0.15 * N**
- **TOTAL UNIT PRICE WITH VAT = N + O**

X – Turnover tax and related unit price:

If the contractor is not registered for VAT, the contractor's unit price in his tender is the sum of direct unit cost (H), indirect unit cost (K), risk allowance (L) and gross profit (M) plus 2% of this sum based on the Turnover tax proclamation No. 308/2002.[39]

- **TURNOVER TAX (N) = 0.02 * (H + K + L + M)**
- **TOTAL UNIT PRICE = H + K + L + M + N**

6 – MATERIAL UNIT COST ESTIMATION

Material unit cost is the total unit cost of a construction material at the project site required to execute a specific activity in the project. In estimating the material unit cost, the contractor shall obtain the quantity and quality of materials required to produce the specific unit of activity from his construction method statements.

Construction materials required for the execution of construction projects are normally purchased either from the local market or international market depending on the availability and material prices. In order to have a better material cost estimation, contractors shall develop their own material price database and the database should contain, but not limited to, the following information:

- ✓ Material price at place of delivery
- ✓ Supplier's address such as telephone, fax and mail address
- ✓ Supplier's contact person
- ✓ Supplier's email address and web site
- ✓ Supplier's credit facility
- ✓ Country of origin
- ✓ Material delivery time
- ✓ Place of delivery such as at the supplier's shop, project site, Addis Ababa air port or Djibouti port
- ✓ Transportation charges usually per ton-km as well as transporters address such as telephone, fax, mail and email addresses as well as web sites

Generally, whether the construction materials are purchased from the local market or the international market, the material price shall include the supplier's price at place of delivery, transportation cost to the project site and the cost of all relevant taxations.

6-1 – MATERIALS PURCHASED FROM LOCAL MARKET

When construction materials are purchased from the local market, the material supplier's price obviously includes all relevant taxations and there is no need for the contractor to consider any inclusion of taxes. However, the contractor shall add the following costs to the material supplier's price to get the material unit cost at the project site:

- ✓ Loading expenses at the supplier's place of delivery
- ✓ Transportation costs to the project site
- ✓ Insurance charges during transportation to the project site
- ✓ Unloading expenses at the project site

According to the tax laws of Ethiopia, material suppliers and producers with annual sales greater than 500,000 birr are obliged to register for Value Added Tax (VAT) according to the Value Added Tax Proclamation No. 285/2002.[38]

On the other hand, suppliers and producers with annual sales less than 500,000 birr are obliged to register for Turnover Tax according to the Turnover Tax Proclamation No. 308/2002.[39]

If the contractor is registered for VAT, which is usually the case, every Value Added Tax paid to material suppliers or producers can be claimed from the Federal Inland Revenue Authority. Therefore, the contractor shall deduct the Value Added Tax amount from the supplier's material price in calculating the material unit costs.

However, if the contractor has purchased the construction materials from suppliers registered for Turnover Tax, there is no chance for the contractor to claim the Turnover Tax amount from the Federal Inland Revenue Authority and the material unit cost shall include the amount of the Turnover Tax paid.

According to the respective proclamations, the amount and basis for calculating the Value Added Tax and the Turnover Tax are given below:

- ⇨ *Value Added Tax shall be levied and paid at the rate of 15% of the value of every taxable transaction by a registered person and every import of goods, other than exempt import as well as an import of services as provided in the proclamation. Moreover, Value Added Tax is computed based on the amount a person receives or is entitled to receive for the supply of goods or rendering of services, whether from the customer or any other person including any duty taxes, or other fee payable but without including VAT.* [38]

- ⇨ *The rate of Turnover Tax is 2% on goods sold locally as well as for services rendered locally i.e. contractors, grain mills, tractors and combine-harvesters. But, it is 10% on other locally rendered services. Moreover, the computation of Turnover Tax shall be on the gross receipts in respect of goods supplied or services rendered.* [39]

Last but not least, VAT registered contractors are advised to purchase construction materials from VAT registered material supplier's instead of the Turnover Tax registered suppliers as far as the material price without VAT is less than that of the Turnover Tax registered material suppliers price.

As an example, let's calculate the material unit costs of concrete materials required for a residential building to be constructed by a VAT registered Building Contractor Grade 4 at CMC in Addis Ababa. Based on the actual material price in Addis during the month of March 2006, the concrete material unit costs are calculated at the project site as follows:

❖ **Coarse Aggregate (20mm):**

A. Material source……..…...Legehar
B. Material price at Legehar……140.00 Birr/m^3
C. Loading cost……..……8.00 Birr/ m^3
D. Transportation cost with dump truck…….. 50.00 Birr/ m^3

⇨ *Coarse aggregate unit cost = B + C + D*
⇨ *Coarse aggregate unit cost = 140 + 8 + 50*

↳ ***Coarse aggregate unit cost = 198.00 Birr/m^3***

❖ **Fine Aggregate (Natural sand):**

A. Material source……..……Legahar
B. Material price at Legahar…… 140.00 Birr/m^3
C. Loading cost……..…..5.00 Birr/ m^3
D. Transportation cost with dump truck…….. 50.00 Birr/ m^3

⇨ *Fine aggregate unit cost = B + C + D*
⇨ *Fine aggregate unit cost =140 + 5 + 50*

↳ ***Fine aggregate unit cost = 195.00 Birr/m^3***

❖ **Cement (Portland Pozzolana Cement):**

A. Material source……..Muger Cement Factory
B. Material price at the factory without VAT……70.84 Birr/Quintal
C. Transportation cost ……..12.00 Birr/Quintal
D. Unloading cost at the site……1.00 Birr/Quintal

⇨ *Portland Pozzolana Cement unit cost = B + C + D*
⇨ *Portland Pozzolana Cement unit cost = 70.84 + 12 + 1*

↳ ***Portland Pozzolana Cement unit cost = 83.84 Birr/Quintal***

❖ **Water:**

A. Material source……Addis Ababa Water and Sewerage Authority
B. Customer category……..…..Domestic – 3rd block
C. Material price……....3.75 Birr/m^3
*D. Environmental protection (**5% of C**)…….. 0.19 Birr/m^3*

⇨ *Water unit cost = C + D*
⇨ *Water unit cost = 3.75 + 0.19*

↳ ***Water unit cost = 3.94 Birr/m^3***

6-2 – MATERIALS PURCHASED FROM INTERNATIONAL MARKET

In the process of construction cost estimation, if a contractor is considering to purchase construction materials from the international market, the contractor shall have a proper understanding of the international commercial terms in estimating the material unit cost at the project site. Depending on the type of material price collected from suppliers, the contractor shall clearly identify and compute all the additional costs to be added to the supplier's material price to get the material unit cost at the project site.

Basically, there are fourteen internationally accepted commercial terms with uniform rules for interpretation published by the International Chamber of Commerce (ICC) whereby the values of uniform rules for interpretation of trade terms are recognized by buyers and sellers who seek clear definitions of their rights and obligations in the international transactions. [12,13]

A – Ex Works (EXW):

If the seller's material price is "Ex Works", the seller's only responsibility is to make the materials available at his premises i.e. warehouse, works or factory not cleared for export. In this case, the seller is not responsible for loading these materials to the transporting trucks or other means supplied by the buyer. The buyer bears the full cost and risk involved in bringing the materials from the seller's premises to the buyer's destination.

Generally, the title and risks pass to the buyer including payment of all transportation and insurance costs from the seller's door. "Ex works" has minimum obligation to the seller and it can be used for any mode of transportation.

B – Free Carrier (FCA):

According to the "Free Carrier", the seller fulfills his obligations when he delivers the materials into the custody of the carrier at the named place. It should be noted that the chosen place of delivery has an impact on the obligations of loading and unloading at that place. If delivery occurs at the seller's premises, the seller is responsible for loading. However, if delivery occurs at any other place, the seller is not responsible for unloading.

Carrier means any person by whom or in whose name a contract of carriage by road, rail, air, sea or a combination modes has been made.

The title and risks pass to the buyer including transportation and insurance costs when the seller delivers cleared materials for export to the carrier at the named place. This commercial term can be used for any mode of transport.

C – Free Alongside Ship (FAS):

Under the "Free Alongside Ship", the seller's obligations are fulfilled when the materials are placed cleared for export alongside the ship on the quay. In the earlier versions of incoterms, export clearance was the obligation of the buyer.

The title and risks pass to the buyer including payment of all transportation and insurance costs once materials are delivered alongside ship by the seller and this term is particularly used for sea or inland waterway transportation.

D – Free On Board (FOB):

If material prices are given as "Free On Board", the seller's obligation is to place the materials on the ship as well as clearance of these materials for export.

The title and risks pass to the buyer including payment of all transportation and insurance costs once delivered on board the ship by the seller and this term is particularly used for sea or inland waterway transportation.

E – Free On Rail / Free On Truck (FOR/FOT):

These commercial terms are the same as that of the "Free On Board" except the mode of transportation is a railway or a truck. If material prices are given as "Free On Rail or Free On Truck", the seller's obligation is to place the materials on the railway wagons or trucks as well as clearance of these materials for export.

The title and risks pass to the buyer including payment of all transportation and insurance costs once the materials are delivered on the railway wagons or trucks by the seller and this term is particularly used for railway or road transportation.

F – Cost and Freight (C&F/CFR):

According to the "Cost and Freight" material prices, the seller must pay the costs and freight necessary to bring the materials to the named destination, but the risk of loss of or damage to the materials, as well as any cost increases, is transferred from the seller to the buyer when the materials pass the ship's rail at the port of shipment. The "Cost and Freight" requires the seller to clear the goods for export.

The title and risks pass to the buyer including all payments of insurance costs when materials are delivered on board the ship by seller who pays the transportation cost to the destination port and this term is particularly used for sea or inland waterway transportation.

G – Cost, Insurance and Freight (CIF):

The "Cost, Insurance and Freight" material price is basically the same as that of the "Cost and Freight" material price except with the addition that the seller has to procure the marine insurance against the risk of loss of or damage to the materials during the carriage and the seller contracts with the insurer and pays the insurance premium. The "Cost, Insurance and Freight" requires the seller to clear the goods for export.

The title and risks pass to buyer when materials are delivered on board the ship by seller who pays transportation and insurance cost to the destination port and this term is particularly used for sea or inland waterway transportation.

H – Carriage Paid To (CPT):

In the "Carriage Paid To", the seller pays the freight for the carriage of the materials to the named destination. However, the risk of loss of or damage to the materials, as well as any increases, is transferred from the seller to the buyer when the materials have been delivered into the custody of the first carrier and not at the ships rail. The "Carriage Paid To" requires the seller to clear the goods for export.

The title and risks pass to the buyer including all payments of insurance costs when the materials are delivered to the first carrier by seller who pays transportation cost to destination and it can be used for any mode of transportation.

I – Carriage and Insurance Paid To (CIP):

The "Carriage and Insurance Paid To" is same as that of the Carriage Paid To except the addition that the seller has to procure transport insurance against the risk of loss of or damage to the materials during the carriage. The seller contracts with the insurer and pays the insurance premium. The "Carriage and Insurance Paid To" requires the seller to clear the goods for export.

The title and risks pass to the buyer when the materials are delivered to the first carrier by the seller who pays transportation and insurance costs to destination and it can be used for any mode of transportation.

J – Delivered At Frontier (DAF):

In the case of "Delivered At Frontier", the seller's obligations are fulfilled when the materials are delivered not unloaded at the frontier but cleared for export and un cleared for import before "the customs boarder" of the country named in the sales contract.

The title, risks and responsibility for import clearance pass to buyer when the materials are delivered to the named boarder point by seller. This term is primarily intended to be used when goods are to be carried by rail or road but it may also be used irrespective of the mode of transport.

K – Delivered Ex Ship (DES):

According to the "Delivered Ex Ship", the seller shall deliver the materials to the buyer on board the ship at the destination named in the sales contract.

The title, risks and responsibility for vessel discharge and import clearance pass to buyer when seller delivers the materials on board the ship to destination port and this term is particularly used for sea or inland waterway transportation.

L – Delivered Ex Quay (DEQ):

"Delivered Ex Quay" material price means that the seller makes the materials available to the buyer on the quay at the destination named in the sales contract. There are normally two "Ex Quay" contracts in use namely "Ex Quay (duty paid)" and "Ex Quay (duty unpaid) in which the liability to clear the materials for import are to be met by the buyer instead of the seller.

In the case of the "Delivered Ex Quay" (duty paid), the title and risks pass to the buyer when the materials are delivered on board the ship at the destination point by the seller who delivers the materials on dock at destination point cleared for import.

On the other hand, if it is the Delivered Ex Quay (duty unpaid), the title, risks and responsibility of import clearance pass to the buyer when the seller delivers the materials to the named destination point. The buyer is obliged for import clearance and these sales contracts can be used for ocean shipments.

M – Delivered Duty Unpaid (DDU):

In the "Delivered Duty Unpaid" material price, the seller fulfills his obligation when materials are delivered not unloaded at the buyer's named place in the country of importation whereby import clearance is the obligation of the buyer.

The title and risks pass to the buyer when the materials are delivered to the named destination which can be the project site. The "Delivered Duty Unpaid" can be used for any mode of transportation.

N – Delivered Duty Paid (DDP):

The “Ex Works” signifies the seller’s minimum obligation and the “Delivered Duty Paid” when followed by words naming the buyer’s premises, denotes the other extreme whereby the seller has the maximum obligation. Therefore, in the “Delivered Duty Paid” the seller fulfills his obligation when materials are delivered not unloaded but cleared for importation at the buyer’s named place in the country of importation.

The title and risks pass to the buyer when the materials are delivered to the named destination which can be the project site. The “Delivered Duty Paid” can be used for any mode of transportation.

In order to give a better insight understanding of these international commercial terms, the obligation and responsibilities of the seller and the buyer are summarized in Table 6-1. As shown in this table, a contractor can understand what costs have to be added to the supplier’s price to get the total material unit cost at the project site.

Table 6-1 – Responsibilities of the Seller and Buyer in the International market

SELLER/BUYER RESPONSIBILITIES		SUPPLIER'S MATERIAL PRICE			
		EXW	FCA	FAS	FOB
1	Warehouse Storage and Handling Charges	Seller	Seller	Seller	Seller
2	Warehouse Labor Charges	Seller	Seller	Seller	Seller
3	Export Packing	Seller	Seller	Seller	Seller
4	Loading Charges	Buyer	Seller	Seller	Seller
5	Inland Freight	Buyer	Seller/Buyer	Seller	Seller
6	Terminal Charges	Buyer	Buyer	Seller	Seller
7	Export Taxes	Buyer	Seller	Seller	Seller
8	Export Customs Clearance	Buyer	Seller	Seller	Seller
9	Export Forwarder's Fee	Buyer	Seller	Seller	Seller
10	Loading on Vessel	Buyer	Buyer	Buyer	Seller
11	Ocean/Land/Air Freight	Buyer	Buyer	Buyer	Buyer
12	Ocean/Land/Air Insurance	Buyer	Buyer	Buyer	Buyer
13	Charges on Arrival on Destination	Buyer	Buyer	Buyer	Buyer
14	Import Duty and Taxes	Buyer	Buyer	Buyer	Buyer
15	Import Customs Clearance	Buyer	Buyer	Buyer	Buyer
16	Customs Clearing Agent's Fee	Buyer	Buyer	Buyer	Buyer
17	Inland Transport to the Project Site	Buyer	Buyer	Buyer	Buyer
18	Insurance during Transit to Project Site	Buyer	Buyer	Buyer	Buyer
19	Unloading Charges at Project Site	Buyer	Buyer	Buyer	Buyer
20	Warehouse Storage and Handling at Project Site	Buyer	Buyer	Buyer	Buyer

Table 6-1 (Continued) – Responsibilities of the Seller and Buyer in the International market

SELLER/BUYER RESPONSIBILITIES		SUPPLIER'S MATERIAL PRICE			
		FOR/FOT	C & F / CFR	CIF	CPT
1	Warehouse Storage and Handling Charges	Seller	Seller	Seller	Seller
2	Warehouse Labor Charges	Seller	Seller	Seller	Seller
3	Export Packing	Seller	Seller	Seller	Seller
4	Loading Charges	Seller	Seller	Seller	Seller
5	Inland Freight	Seller	Seller	Seller	Seller
6	Terminal Charges	Seller	Seller	Seller	Seller
7	Export Taxes	Seller	Seller	Seller	Seller
8	Export Customs Clearance	Seller	Seller	Seller	Seller
9	Export Forwarder's Fee	Seller	Seller	Seller	Seller
10	Loading on Vessel	Seller	Seller	Seller	Seller
11	Ocean/Land/Air Freight	Buyer	Seller	Seller	Seller
12	Ocean/Land/Air Insurance	Buyer	Buyer	Seller	Buyer
13	Charges on Arrival on Destination	Buyer	Buyer	Buyer	Seller
14	Import Duty and Taxes	Buyer	Buyer	Buyer	Buyer
15	Import Customs Clearance	Buyer	Buyer	Buyer	Buyer
16	Customs Clearing Agent's Fee	Buyer	Buyer	Buyer	Buyer
17	Inland Transport to the Project Site	Buyer	Buyer	Buyer	Buyer
18	Insurance during Transit to Project Site	Buyer	Buyer	Buyer	Buyer
19	Unloading Charges at Project Site	Buyer	Buyer	Buyer	Buyer
20	Warehouse Storage and Handling at Project Site	Buyer	Buyer	Buyer	Buyer

Table 6-1 (Continued) – Responsibilities of the Seller and Buyer in the International market

SELLER/BUYER RESPONSIBILITIES		SUPPLIER'S MATERIAL PRICE			
		CIP	DAF	DES	DEQ Duty Unpaid
1	Warehouse Storage and Handling Charges	Seller	Seller	Seller	Seller
2	Warehouse Labor Charges	Seller	Seller	Seller	Seller
3	Export Packing	Seller	Seller	Seller	Seller
4	Loading Charges	Seller	Seller	Seller	Seller
5	Inland Freight	Seller	Seller	Seller	Seller
6	Terminal Charges	Seller	Seller	Seller	Seller
7	Export Taxes	Seller	Seller	Seller	Seller
8	Export Customs Clearance	Seller	Seller	Seller	Seller
9	Export Forwarder's Fee	Seller	Seller	Seller	Seller
10	Loading on Vessel	Seller	Seller	Seller	Seller
11	Ocean/Land/Air Freight	Seller	Seller	Seller	Seller
12	Ocean/Land/Air Insurance	Seller	Seller	Seller	Seller
13	Charges on Arrival on Destination	Seller	Buyer	Buyer	Seller
14	Import Duty and Taxes	Buyer	Buyer	Buyer	Buyer
15	Import Customs Clearance	Buyer	Buyer	Buyer	Buyer
16	Customs Clearing Agent's Fee	Buyer	Buyer	Buyer	Buyer
17	Inland Transport to the Project Site	Buyer	Buyer	Buyer	Buyer
18	Insurance during Transit to Project Site	Buyer	Buyer	Buyer	Buyer
19	Unloading Charges at Project Site	Buyer	Buyer	Buyer	Buyer
20	Warehouse Storage and Handling at Project Site	Buyer	Buyer	Buyer	Buyer

Table 6-1 (Continued) – Responsibilities of the Seller and Buyer in the International market

SELLER/BUYER RESPONSIBILITIES		SUPPLIER'S MATERIAL PRICE			
		DEQ Duty Paid	DDU	DDP	
1	Warehouse Storage and Handling Charges	Seller	Seller	Seller	
2	Warehouse Labor Charges	Seller	Seller	Seller	
3	Export Packing	Seller	Seller	Seller	
4	Loading Charges	Seller	Seller	Seller	
5	Inland Freight	Seller	Seller	Seller	
6	Terminal Charges	Seller	Seller	Seller	
7	Export Taxes	Seller	Seller	Seller	
8	Export Customs Clearance	Seller	Seller	Seller	
9	Export Forwarder's Fee	Seller	Seller	Seller	
10	Loading on Vessel	Seller	Seller	Seller	
11	Ocean/Land/Air Freight	Seller	Seller	Seller	
12	Ocean/Land/Air Insurance	Seller	Seller	Seller	
13	Charges on Arrival on Destination	Seller	Seller	Seller	
14	Import Duty and Taxes	Seller	Buyer	Seller	
15	Import Customs Clearance	Seller	Buyer	Seller	
16	Customs Clearing Agent's Fee	Seller	Buyer	Seller	
17	Inland Transport to the Project Site	Buyer	Seller	Seller	
18	Insurance during Transit to Project Site	Buyer	Seller	Seller	
19	Unloading Charges at Project Site	Buyer	Buyer	Buyer	
20	Warehouse Storage and Handling at Project Site	Buyer	Buyer	Buyer	

Unless otherwise local contractors are familiar with sound experience of the international market including overseas transportation costs, insurance, export duties and taxes, customs and port clearance as well as any other risks, they are advised to collect material prices whereby all overseas costs and risks are covered by suppliers.

On the other hand, even though, the "Delivered Duty Paid" price has minimum risks to the contractor, the suppliers' material price can be higher as suppliers may not have adequate experience in Ethiopia regarding the transportation costs, duties and taxes, customs and port clearance, insurance as well as any other risks.

Therefore, it is advisable and convenient that local contractors better collect CIF material prices at the port of Djibouti or any other convenient port where local contractors are or shall be familiar with all the transportation costs, duties and taxes, customs and port clearance, insurance as well as any other risks both at the port of Djibouti or any other convenient port and in Ethiopia.

Unless otherwise stated on the contract conditions and investment incentives, contractors shall add the following costs, but not limited, to the CIF Djibouti price to get the final material unit cost at the project site.

- Port clearance
- Duty
- Excise tax
- Value Added Tax
- Customs clearance
- Clearing Agent's fee
- Transportation cost from Port to the project site
- Insurance, if required, during transportation
- Unloading expenses at the project site

In calculating the material unit cost at the project site, even though very difficult to calculate the costs of customs and port clearance charges as well as the clearing agent's fee for each type of construction material, previous local clearing agent's experiences indicate that each of the customs clearance, port clearance as well as the clearing agent's fee is about 1% of the CIF price.

Moreover, contractors shall add the amount of Duty to be paid based on the type of material imported and incase the material imported is subject to excise taxation, the amount of Excise tax to be paid shall also be added to the material unit cost based on the type of material imported.

Local contractors are also advised to refer to the Ethiopian Customs Authority Customs Tariff which states the amount of Duty and Excise taxes for each type of materials and equipments imported. [36,37]

Furthermore, according to the respective proclamations, the basis for computing the Duty and Excise taxes are given below:

- ⇨ *The Duty paying value for imported materials shall be the transaction value, freight cost and insurance premium paid to deliver the materials up to a specified customs port.* [41]

- ⇨ *The base for computation of Excise tax for imported materials is the sum of the transaction value, freight cost and insurance premium paid i.e. the CIF price of the imported material.* [40]

Even though, Value Added Tax shall be paid to all imported construction materials, contractors should not include the amount of the Value Added Tax in calculating the material unit cost at the project site as Value Added Tax paid is recoverable from the Federal Inland Revenue Authority.

The other important cost to be added is the inland transportation cost from the Port to the project site which is about 0.5 Birr/ton-km based on the local transport market during the month of February 2006.

Moreover, one may also consider insurance charges during inland transportation of the construction materials to the project site from the Port. However, unless construction chemicals, glasses, cement products, electrical as well as sanitary fixtures, the risk of damage to most construction materials during inland transport is negligible. Incase, a contractor wants to insure his material during inland transport, the insurance premium widely varies among the local insurance companies based on the type and quantity of materials to be transported. Therefore, contractors are advised to collect insurance data from the specific insurance company where the contractor wants to insure his materials.

As an example, let's see how a contractor shall calculate the material unit cost of imported reinforcement steel bar to be used in a construction project located in Addis. Assume the CIF price at Djibouti Port is 4,115.53 Birr/ton (Data collected from Gift Trading Ethiopia during the month of March 2006)

- ❖ **CIF price:**

  A. *Customs Port……..…….Djibouti*
  B. *Reinforcement steel bar CIF price…..……4,115.53 Birr/ton*

  - ⇘ ***CIF price at Djibouti Port = 4,115.53 Birr/ton***

- ❖ **Duty to be paid:**

  A. *CIF price at Djibouti Port ……...4,115.53 Birr/ton*
  B. *Amount of Duty to be paid……10% of A (Customs Tariff)*

  - ⇘ ***Duty to be paid = 411.55 Birr/ton***

❖ **Excise tax:**

A. CIF price at Djibouti Port ……..4,115.53 Birr/ton
B. Amount of Excise tax be paid……0% of A (Customs Tariff)

➧ ***Excise tax to be paid = 0.00 Birr/ton***

❖ **Value Added Tax:**

A. CIF price at Djibouti Port ……..….4,115.53 Birr/ton
B. Duty to be paid……..…..411.55 Birr/ton
C. Excise tax to be paid……...0.00 Birr/ton
*D. Amount of Value Added Tax……..…..**15% of (A+B+C)***

⇨ ***Value Added Tax = 0.15*(4,115.53 + 411.55 + 0.00)***
➧ ***Value Added Tax to be paid = 679.06 Birr/ton***

❖ **Port clearance:**

A. CIF price at Djibouti Port ……...4,115.53 Birr/ton
*B. Port clearance charges……..……**1% of A (Estimate)***

➧ ***Port clearance charges = 41.16 Birr/ton***

❖ **Customs clearance:**

A. CIF price at Djibouti Port ……...4,115.53 Birr/ton
*B. Customs clearance charges……..……**1% of A (Estimate)***

➧ ***Customs clearance charges = 41.16 Birr/ton***

❖ **Clearing agent's fee:**

A. CIF price at Djibouti Port ……...4,115.53 Birr/ton
*B. Clearing agent's fee…..……..……**1% of A** (Estimate)*

⇨ ***Clearing agent's fee = 41.16 Birr/ton***

❖ **Inland transport:**

A. Distance between Djibouti Port and Addis……..925 Km
B. Inland transport charges…..……..……0.5 Birr/ton-km
*C. Inland transport cost……..**A*B***

⇨ ***Inland transport cost = 0.5 * 925 Birr/ton***
➧ ***Inland transport cost = 462.50 Birr/ton***

❖ **Inland transport insurance:**

Assume the contractor considers inland transport insurance is not necessary to transport reinforcement steel bars due to negligible damage is expected during transportation to Addis.

↳ ***Inland transport insurance premium = 0.00 Birr/ton***

❖ **Unloading cost at project site:**

A. Assumed unloading method……...Labor
B. Labor unloading costs…….....10.00 Birr/ton (market price)

↳ ***Unloading costs at project site = 10.00 Birr/ton***

Therefore, once all required cost components are estimated, the total reinforcement steel bar unit cost at the project site in Addis is computed as the sum of all these costs i.e. Reinforcement CIF price, Duty to be paid, Excise tax, Value Added Tax, Port clearance charges, Customs clearance charges, Clearing agent's fee, Inland transportation, Inland transport insurance premium and Unloading costs at the project site.

⇨ ***Reinforcement steel bar unit cost at project site = 5,802.12 Birr/ton***

However, assuming the contractor is registered for VAT, Value Added Tax paid shall be deducted from the total material unit cost at the project site as it is recoverable from the Federal Inland Revenue Authority and total reinforcement steel bar unit cost at the project site is recalculated as follows:

⇨ ***Reinforcement steel bar unit cost without VAT = 5,802.12 – 679.06***

↳ ***Reinforcement bar unit cost without VAT = 5,123.06 Birr/ton***

7 – LABOR HOURLY COST ESTIMATION

The direct labor hourly cost is the total cost of labor per hour at the project site required to execute a specific construction activity in a project, which mainly refers to the skilled and unskilled workers.

The direct labor hourly cost widely varies from company to company based on the contractors' salary and other benefits scale such as food allowance, insurance, hardship allowance, project allowance, severance pay, provident fund, annual leave, bonuses, per diem and any other benefits specially based on collective agreements in between the contractor and the workers.

However, even though, the direct labor hourly cost can vary from company to company, every contractor working in Ethiopia shall thoroughly check the Ethiopian labor law from time to time which dictates the minimum employee benefits whereby the contractor is legally bound to pay to his employees.

As an illustration, let's see what minimum benefits shall a contractor fulfill to his workers in addition to their basic salaries according to the Labor Proclamation No. 377/2003. [42]

- ⇨ Severance pay
- ⇨ Annual leave
- ⇨ Occupational accident expenses
- ⇨ Occupational disease expenses
- ⇨ Overtime pay
- ⇨ Occupational safety, health and working environment
- ⇨ Benefits resulting from collective agreements

A – Severance pay:

In accordance with the Labor Proclamation No. 377/2003, when an employment contract is terminated due to decrease in the volume of construction works as a result of its successive completion, the contractor is legally bound to pay severance pay to his workers as follows:

- ⇨ *Thirty times the average daily wages of the last week service for the first year of service and for service of less than one year, severance pay shall be calculated in proportion to the period of service.*

- ⇨ *In case a worker has served for more than one year, payment shall be increased by one-third for every additional year of service, provided that the total severance pay shall not exceed twelve month wage of the worker.*

B – Annual leave:

Under this labor law, workers are entitled to uninterrupted annual leave as stated below. Therefore, a contractor shall calculate the additional labor costs related to workers annual leave.

- ⇨ *Fourteen working days for the first one year service.*
- ⇨ *Fourteen working days plus one working day for every additional year of service.*
- ⇨ *Where the length of service of an employee is less than one year, the employee shall be entitled to annual leave proportion to the length of his/her service.*

C – Occupational accident and disease expenses:

Under the Labor Proclamation No. 377/2003, occupational accidents are defined as any organic injury or functional disorder sustained by a worker as a result of any cause extraneous to the injured worker or any effort the worker makes during or in connection with the performance of his/her work.

Moreover, occupational diseases are also defined as any pathological condition whether caused by physical, chemical or biological agents which arises as a consequences of the type of work performed by the worker or the surroundings in which the worker is obliged to work during a certain period prior to the date in which the disease become evident.

In cases whereby a worker has got occupational accident and/or disease, the contractor shall cover the following medical and cash expenses:

- ⇨ *General and specialized medical expenses, surgical expenses as well as hospital and pharmaceutical expenses.*
- ⇨ *Periodical payment while the worker is temporarily disabled. Moreover, if the worker sustains permanent disablement, the contractor shall also pay disablement pension or gratuity or compensation.*
- ⇨ *Incase the worker dies, the contractor has to pay compensation to the worker's dependents as stated in the proclamation.*

Generally, estimating the risks of occupational accidents and diseases is very difficult unless the contractor has a sound experience. Therefore, local contractors are advised to insure their workers for both the occupational accidents and diseases. Even though the insurance premium widely varies among the local insurance companies based on the number of workers, salary, type of project and so on, the current average annual insurance premium in Ethiopia is about 1.5% of the workers annual basic salary.

D – Overtime pay:

As a contractor, it is very normal to work overtime hours at the construction sites for different reasons such as to speed up delayed progress of works. According to the Labor Proclamation No. 377/2003, in addition to his basic salary, a worker who works overtime hours shall be entitled at least to the following payments:

- ⇨ *In the case of overtime work done is between 6 a.m. in the morning and 10 p.m. in the evening, 1.25 times the ordinary hourly rate.*
- ⇨ *On the other hand, if the overtime work is done between 10 p.m. in the evening and 6 a.m. in the morning, 1.5 times the ordinary hourly rate.*
- ⇨ *Moreover, if the overtime work is done on weekly rest day, 2 times the ordinary hourly rate.*
- ⇨ *Last but not least, if the overtime work is done on public holidays, 2.5 times the ordinary hourly rate.*

E – Occupational safety, health and working environment:

The contractor is also legally bound to take necessary measures to safeguard the health and safety of the workers and shall particularly provide his workers with protective equipments, clothing and other necessary materials. Depending on the type of work to be performed, the contractor may be required, but not limited, to provide the following items:

- ✓ Working clothes
- ✓ Safety shoes
- ✓ Safety belts
- ✓ Helmets
- ✓ Goggles
- ✓ Safety apron
- ✓ Breathing apparatus equipped with oxygen
- ✓ Ear protectors
- ✓ Gloves

Most of the safety materials are normally used by many workers at different times and it is better to include the cost of safety, health and working environment to the indirect cost of the project.

F – Benefits resulting from collective agreements:

Based on the Labor Proclamation No. 377/2003, collective agreements between the contractor and his workers are legally applicable when the collective agreement is more favorable to the workers in similar matters than these provided for by law. However, when the law is more favorable to the workers

than the collective agreement, the law shall be applicable. Generally, even though, the Ethiopian labor law dictates the minimum benefits to the workers, contractors need to have their own salary and other benefits scales depending on, but not limited to, the following conditions:

- ✓ Project location
- ✓ Labor market
- ✓ Type of project
- ✓ Complexity of project
- ✓ Project time for completion
- ✓ Project weather conditions
- ✓ Project site facilities
- ✓ Level of skill required
- ✓ Type of skill required

Normally, direct labor can be employed on monthly or daily basis whichever is convenient mainly for the contractor. The current practice in Ethiopia shows most local contractors employ direct labor on daily basis.

As an example, let's see how to estimate the direct labor hourly cost for a carpenter, mason, bar bender and unskilled labor working at a high rise building project located in Addis Ababa based on the following assumptions:

- ✓ *Project location……...Addis Ababa*
- ✓ *Project working hours……10hrs per day*
- ✓ *Rest days……..Every Sunday*
- ✓ *Employment……..On daily basis*
- ✓ *Bonuses……One month salary per year*
- ✓ *Medical insurance……1.5% of annual salary*
- ✓ *Annual leave……...14 working days for the first year*
- ✓ *Moreover, as construction workers are highly mobile for different reasons mainly of other better job opportunities, assume a worker will work on average for one year on the project.*

Let's demonstrate the carpenter hourly cost calculation and with similar manner the hourly cost for mason, bar bender and unskilled labor are also calculated and summarized under Table 7-1.

❖ **Basic salary:**

A. Basic daily salary……..30.00 Birr/day (Market labor price)
B. Working hours per day……8 hours (Labor Proclamation No. 377/2003)

⇨ ***Basic hourly salary = A/B***
⇨ ***Basic hourly salary = 30/8***

⇨ ***Basic hourly salary = 3.75 Birr***

❖ **Overtime pay:**

A. Normal overtime hours per day……..2 hours
B. Working hours per day……8 hours
C. Working days per month……..26 days (30 – 4 Sundays)

In this case, the additional cost to be considered is the difference between the ordinary pay and overtime pay for the overtime work performed. As a result, the additional multiplying factor is 0.25 for normal overtime working hours.

⇨ ***Overtime hourly pay = A*(0.25*3.75)/B***
⇨ ***Overtime hourly pay = 2*(0.25*3.75)/8***

⇩ ***Overtime hourly pay = 0.23 Birr***

❖ **Bonus:**

A. Annual bonus……..…...one month salary per year
B. Working days per year……..313 days (365 – 52 Sundays)
*C. Amount of bonus per year……..…...780.00 Birr (26 days * 30 Birr/day)*

⇨ ***Hourly bonus = C/(B*8)***
⇨ ***Hourly bonus = 780/(313*8)***

⇩ ***Hourly bonus = 0.31 Birr***

❖ **Medical insurance:**

A. Medical insurance……...1.5% of annual salary
*B. Annual salary…..……..10,950 Birr (30 Birr/day*365days)*

⇨ ***Hourly medical insurance = 0.015*B/(313*8)***
⇨ ***Hourly medical insurance = 0.015*10950/(313*8)***

⇩ ***Hourly medical insurance = 0.07 Birr***

❖ **Severance pay:**

A. Severance pay……..30 days salary for one year service (Labor law)
*B. Amount of severance pay……....900 Birr (30 days * 30 Birr/day))*

⇨ ***Hourly severance pay = B/(313*8)***
⇨ ***Hourly severance pay = 900/(313*8)***

⇩ ***Hourly severance pay = 0.36 Birr***

❖ **Annual leave:**

A. Annual leave……..14 working days for one year service
*B. Amount of annual leave pay……..420 Birr (14 days * 30 Birr/day))*

⇨ ***Hourly annual leave pay = B/(313*8)***
⇨ ***Hourly annual leave pay = 420/(313*8)***

⇨ ***Hourly annual leave pay = 0.17 Birr***

The hourly labor cost summary for carpenter, mason, bar bender and unskilled labor are summarized under Table 7-1, which indicates the contractor shall increase the basic salary of his direct labor by 30% based on the given assumptions to get the total hourly direct labor cost.

Table 7-1 – Direct labor hourly cost summary

SALARY AND BENEFITS		TYPE OF LABOR BY SKILL			
		Carpenter	Mason	Bar Bender	Unskilled Labor
1	Basic salary	3.75	3.75	3.13	1.25
2	Overtime pay	0.23	0.23	0.20	0.08
3	Bonus	0.31	0.31	0.26	0.10
4	Medical Insurance	0.07	0.07	0.05	0.02
5	Severance pay	0.36	0.36	0.30	0.12
6	Annual leave	0.17	0.17	0.14	0.06
A = BASIC SALARY		3.75	3.75	3.13	1.25
B = OTHER BENFITS		1.14	1.14	0.95	0.38
C = B/A (Other benefits/Basic salary)		0.30	0.30	0.30	0.30
D = Labor Index		**1.30**	**1.30**	**1.30**	**1.30**

8 – EQUIPMENT HOURLY COST ESTIMATION

Construction equipments required for the execution of a certain construction project are either owned or rented from equipment leasing companies. In the process of construction cost estimation, the contractor will normally assume the intended construction activities will be performed using his own equipments or rented equipments from others, if equipments are required for the execution of these activities.

When using owned equipments in the activity cost estimate breakdowns, contractors shall calculate the associated hourly costs to operate each equipment on the intended project during the equipment's economic life. However, if rented equipments are assumed in the activity cost breakdowns, contractors shall obtain equipment hourly rental rates directly from equipment leasing companies.

Therefore, a contractor must develop the hourly equipment costs for each of his own equipments based on the associated costs during the economic life of the equipments. These associated equipment costs are mainly classified into three categories as follows:

- ⇨ Equipment owning costs
- ⇨ Equipment operating costs
- ⇨ Operator's salary and benefits

Basically contractors need to know in depth how to calculate the equipment hourly costs especially for owned equipments. Therefore, under this chapter, equipment owning costs, equipment operating costs as well as operator's salary and benefits will be discussed in detail.

Moreover, as an illustration, the equipment hourly costs for two Caterpillar earthmoving equipments i.e. crawler mounted D8R dozer and wheel mounted 950G loader will be worked out based on the local actual market data collected during the month of March 2006. In addition, in order to give a complete insight to the establishment of equipment hourly rental rate, equipment owner's overhead costs as well as profit margins and income tax will also be discussed.

8-1 – EQUIPMENT OWNING COSTS

Equipment owning costs are all these costs in which the owner of the equipment expends throughout the economic life of the equipment whether the equipment is working or not. These costs include mainly the depreciation cost of the equipment with the consideration of its salvage value, Erection and installation costs, major repairs and overhauling costs, property taxes and insurance charges.

A – Depreciation cost:

In order to calculate the hourly equipment depreciation cost, the contractor shall calculate the total equipment delivered price which is the total cost of the equipment expended by the contractor until the equipment is delivered at his workshop starting from the date of purchase from his suppliers which includes the initial purchase price, insurance charges, transportation costs and any applicable taxes excluding Value Added Tax. The international commercial terms discussed under chapter 6 are also applicable to the purchase of equipments.

Normally, the equipment delivered price i.e. equipment owner's investment shall be recovered by prorating these costs during the economic life of the equipment which is called depreciation. However, in calculating the depreciation cost of equipment, the cost of tires shall be deducted from the delivered price for rubber wheel mounted equipments. Rubber tires shall be treated as operating costs because of their shorter economic life as compared to the basic equipment and tires need to be replaced many times during the economic life of the equipment.

The economic life of equipments entirely depends on the type of equipment, operator's skill, repair and maintenance, type of work to be performed, weather conditions and so on. Therefore, more accurate estimated economic life of equipments can be obtained from the contractor's well recorded equipment performance historical data and other companies' experience owning similar equipments. However, in the absence of such reliable data, it is better to use the equipment manufacturers' guide to estimate the economic life of the equipment such as the Caterpillar Performance Handbook provided for Caterpillar make equipments. [26]

The depreciation cost can be calculated in many different ways such as the straight line, declining balance, sum of years-digits and unit production methods. In this case, it is better to use the unit production depreciation method to calculate the equipment depreciation cost which actually relates the depreciation cost with the real utilization of the equipment.

Moreover, the cost of capital of the contractor shall be included in the calculations of the depreciation cost of equipments. Different contractors do have different cost of capital and contractors are advised to establish their own cost of capital. However, in the absence of such data, it is fair to use the lending rate of the Commercial Bank of Ethiopia which is 7.5% during the month of March 2006. [31]

In addition, if accurate economic data is available, contractors may also consider inflation conditions in establishing the hourly depreciation cost of equipment. Contractors may obtain such kind of economic data from the National Bank of Ethiopia and the Ethiopian Central Statistics Agency.

Salvage value of the equipment is the other important point to be considered in calculating depreciation costs. Even though not reasonable, many contractors prefer to assume zero salvage value which will actually overestimate the depreciation cost of equipments. The salvage value of equipment mainly depends on the type of jobs and operating conditions where it has been deployed and its physical conditions. Accurate salvage value estimates can be obtained from the contractor's well recorded previous data, second hand equipment selling companies, recent auction prices, economic indices on construction equipments, local equipment dealers and so on. However, in the absence of reliable data and market indications, salvage value of equipment can be assumed 10% of its delivered price. [29]

Once all the required cost related data are obtained such as equipment delivered price, economic life and its salvage value, the equipment depreciation cost can be calculated easily using the time value method. The time value method recognizes the timing of equipment cash flows i.e. the delivered price less the cost of tires at time zero and the salvage value at the future date which is at the end of its economic life. The uniform series capital recovery factor formula is used to determine the equipment's annual cost of delivered price less tire costs and to account for the salvage cash inflow the uniform series sinking fund factor formula is used.

Let's demonstrate to establish the equipment hourly depreciation cost for crawler mounted and wheel mounted equipments with the following two examples using the time value method whereby the uniform series capital recovery factor formula will be used to determine the equipment's annual cost of delivered price less tire costs and the uniform series sinking fund factor formula to account for the salvage cash inflow as discussed earlier.

EXAMPLE – 1

Assume a contractor has purchased a new Caterpillar D8R Bulldozer with a delivered duty paid price of birr 3,871,739.13 without VAT at his premises. Calculate the hourly depreciation cost of the specified Bulldozer.

A. *Delivered price …….. Birr 3,871,739.13*

B. *Cost of tires……..Birr 0.00 (Crawler mounted equipment)*

C. *Delivered price less cost of tires (P)……Birr 3,871,739.13*

D. *Assume the Bulldozer will be engaged partly in works such as borrow material production and common excavation with medium impact as well as in heavy rock ripping and dozing hard rock with high impact conditions.*

   ⇨ *Estimated economic life = Assume 10 Years* [26]

E. *Estimated annual utilization…….. 2000 Hrs* [26]

F. *Estimated salvage value……..(S = 10% delivered price)*

   ⇨ *S = 0.1 * 3,871,739.13 = Birr 387,173.91*

G. *Estimated cost of capital…… (I = 7.5%)*

H. *Equivalent annual equipment cost of delivered price less cost of tires*

$$A1 = P * [I (1+I)^n] / [(1+I)^n – 1]$$

$$A1 = 3,871,739.13 * [0.075(1+0.075)^{10}] / [(1+0.075)^{10} – 1]$$

$$A1 = 564,057.91 \text{ Birr/Year}$$

I. *Equivalent annual salvage value*

$$A2 = S * I / [(1+I)^n – 1]$$

$$A2 = 387,173.91 * 0.075 / [(1+0.075)^{10} – 1]$$

$$A2 = 27,367.75 \text{ Birr/Year}$$

J. *Dozer Depreciation Cost per hour* ***(DDC)***

   ⇨ *DDC = (A1 – A2) / E*

   ⇨ *DDC = (564,057.91 – 27,367.75)/2000*

   ⇨ ***DDC = 268.35 Birr/Hr***

EXAMPLE – 2

The same contractor has purchased a new Caterpillar 950G Wheel loader with a delivered duty paid price of birr 1,785,478.26 without VAT at his premises. Moreover, the price of tires is birr 14,115.22 per tire without VAT, which is birr 56,460.88 for 4 tires. Calculate the hourly depreciation cost of the specified wheel loader.

A. *Delivered price ……..…..….. Birr 1,785,478.26*

B. *Cost of tires…….……...……..Birr 56,460.88*

C. *Delivered price less cost of tires (P)……Birr 1,729,017.38*

D. *Assume the Wheel loader will be engaged mostly in continuous loading from stock pile*

   ⇨ *Estimated economic life = Assume 8 Years* [26]

E. *Estimated annual utilization…….. 1250 Hrs* [26]

F. *Estimated salvage value……..(S = 10% delivered price)*

   ⇨ *S = 0.1 * 1,785,478.26 = Birr 178,547.83*

G. *Estimated cost of capital…… (I = 7.5%)*

H. *Equivalent annual equipment cost of delivered price less cost of tires*

$$A1 = P * [I (1+I)^n] / [(1+I)^n – 1]$$

$$A1 = 1,729,017.38 * [0.075(1+0.075)^8] / [(1+0.075)^8 – 1]$$

$$A1 = 295,189.99 \text{ Birr/Year}$$

I. *Equivalent annual salvage value*

$$A2 = S * I / [(1+I)^n – 1]$$

$$A2 = 178,547.83 * 0.075 / [(1+0.075)^8 – 1]$$

$$A2 = 17,091.85 \text{ Birr/Year}$$

J. *Loader Depreciation Cost per hour* ***(LDC)***

   ⇨ *LDC = (A1 – A2)/E*

   ⇨ *LDC = (295,189.99 – 17,091.85)/1250*

   ⇨ ***LDC = 222.48 Birr/Hr***

B – Insurance charges:

Contractors shall insure their equipments for different accidents that the equipment may face in its economic life as such fire, theft and damages to the equipment as well as the operator and damages to third party's life and properties. In order to cover all these risks, it is better to obtain Comprehensive insurance cover from insurance companies. Different local insurance companies have different negotiable annual comprehensive insurance charges based on the equipment book value and its physical conditions.

Most local insurance companies charge between 0.75 to 1% of the equipment book value for heavy duty equipments and between 1 to 1.5% for light duty equipments such as small vehicles. Therefore, contractors are advised to collect insurance data from the specific insurance company where the contractor wants to insure his equipments.

EXAMPLE 1 - (DOZER D8R)

A. *Delivered price……..……..Birr 3,871,739.13*
B. *Annual insurance charges……..……1% of delivered price*
C. *Estimated annual utilization……..……2000 Hrs*
D. *Dozer Insurance Cost per hour* ***(DIC) = B/C***

⇨ *DIC = 0.01*3,871,739.13/2000*
⇨ ***DIC = 19.36 Birr/Hrs***

EXAMPLE 2 - (WHEEL LOADER 950G)

A. *Delivered price……..……..Birr 1,785,478.26*
B. *Annual insurance charges……..……1% of delivered price*
C. *Estimated annual utilization……..……..1250 Hrs*
D. *Loader Insurance Cost per hour* ***(LIC) = B/C***

⇨ *LIC = 0.01*1,785,478.26/1250*
⇨ ***LIC = 14.28 Birr/Hrs***

C – Property tax:

Different countries have different tax regulations whereby equipment owners pay annual property tax for their equipments. Currently there are no such tax regulations in Ethiopia but there is a registration fee for heavy duty construction equipments every two years as shown in Table 8-1. Even though the hourly cost of equipment registration fee is negligible, it is computed for both equipments in example 1 and 2 for completeness of the hourly equipment owning cost establishment exercise.

Table 8-1 – Heavy Duty Construction Equipment Registration Fee, Every Two Years in Birr

ITEM NO	TYPE OF EQUIPMENT	TOTAL AMOUNT OF REGISTRATION FEE	REMARK
1	Crawler Mounted Dozer	2,000.00	
2	Wheel Loader	1,700.00	
3	Backhoe Loader	900.00	
4	Crawler Mounted Excavator	1,500.00	
5	Grader – CAT 140G	1,500.00	
6	Wheel Tractor Scraper – 21m3	1,500.00	
7	Vibratory Roller – 12ton	800.00	
Source – Ministry of Infrastructure, February 2006			

EXAMPLE 1 - (DOZER D8R)

A. *Registration fee per two years……..Birr 2,000.00*
B. *Estimated annual utilization……..……2000 Hrs*
C. *Dozer Property Tax per hour* ***(DPT) = A/(2*B)***

⇨ *DPT = 2000/(2*2000)*
⇩ ***DPT = 0.5 Birr/Hr***

EXAMPLE 2 - (WHEEL LOADER 950G)

A. *Registration fee per two years ……..Birr 1,700.00*
B. *Estimated annual utilization……..……1250 Hrs*
C. *Loader Property Tax per hour* ***(LPT) = A/(2*B)***

⇨ *LPT = 1700/(2*1250)*
⇩ ***LPT = 0.68 Birr/Hr***

D – Erection and Installation costs:

The initial erection and installation costs shall be considered in calculating the equipment owning costs. These costs are usually applied to equipments which are transported in pieces from the supplier's place and need to be assembled at the contractor's place such as crushers, batching plants and so on. Normally accurate installation and erection cost estimates can be obtained from equipment suppliers.

The erection and installation costs for the above equipments referred in example 1 and 2 are zero as both the D8R dozer and 950G wheel loader equipments are supplied as single unit which do not require further assembly works at the contractor's place.

- ⇨ *Dozer Erection and Installation Costs per hour **(DEIC)**……...0.00 Birr/Hr*
- ⇨ *Loader Erection and Installation Costs per hour **(LEIC)**……....0.00 Birr/Hr*

E – Major repairs and Overhauls:

Major repairs and overhauls shall also be included in the ownership cost of the equipment as they are intended to extend the economic life of the equipment. The estimated cost of major repairs and overhauls can be obtained from the contractor's historical records and equipment manufacturers based on the type of major repairs and overhauls to be performed. Therefore, if major repairs and overhauls are performed to the equipment, these costs shall be added to the book value of the equipment and the depreciation portion of the equipment ownership cost shall be recalculated.

However, the costs of major repairs and overhauls for the above two equipments in example 1 and 2 are not considered as both equipments are new.

- ⇨ *Dozer Major Repair and Overhaul Costs per hour **(DMROC)**……...0.00 Birr/Hr*
- ⇨ *Loader Major Repair and Overhaul Costs per hour **(LMROC)**…....0.00 Birr/Hr*

F – Summarized Equipment Owning costs:

Once the equipment depreciation cost, insurance charges, property tax, erection and installation costs and cost of major repairs and overhauls are identified, all these costs will be summed to get the hourly owning cost of the equipment.

EXAMPLE 1 - (DOZER D8R)

- ⇨ *Hourly owning costs……**DDC + DIC + DPT + DEIC + DMROC***
- ⇨ *Hourly owning costs = 268.35 + 19.36 + 0.50 + 0.00 + 0.00*

- ⇨ ***Hourly owning costs =288.21 Birr/Hr***

EXAMPLE 2 - (WHEEL LOADER 950G)

- ⇨ *Hourly owning costs …….. **LDC + LIC + LPT + LEIC + LMROC***
- ⇨ *Hourly owning costs = 222.48 + 14.28 + 0.68 + 0.00 + 0.00*

- ⇨ ***Hourly owning costs = 237.44 Birr/Hr***

8-2 – EQUIPMENT OPERATING COSTS

Equipment operating costs are costs in which the owner of the equipment expends throughout the economic life of the equipment when it is working. These costs include mainly the costs of fuel, lube oils, filters, grease, normal repairs, tires, undercarriage and special high wear items.

A – Fuel cost:

Equipments fuel consumption can be estimated accurately based on the contractor's service records of equipments depending on the type of work application. However, in the absence of such records, equipment manufacturer's fuel consumption data under different work application can be used in estimating the fuel cost of the equipment.

The equipment work application determines the engine load factor which in turn controls the equipment fuel consumption rate. An engine continuously producing full rated power is operating at a load factor of 1.0. However, earth moving equipments may operate at their maximum engine rated output intermittently. Periods spent idle, dozer travel in reverse, haul units traveling empty, operating downhill, operator's experience are some of the factors whereby equipment engine load factor can be reduced.

As discussed earlier, the fuel consumption data can be obtained from the equipment's fuel consumption records or in the absence of such records, using the estimated fuel consumption rates given by the equipment manufacturers based on work application and the engine load factor, the hourly fuel cost can be determined by multiplying the hourly fuel consumption by the local unit price of fuel.

Based on the estimated fuel consumption data provided by Caterpillar Performance Hand Book [26], the fuel cost of the equipments in example 1 and 2 are computed taking into consideration of the fuel price in Addis during the month of November 2005, which is 4.31Birr/Ltr.

EXAMPLE 1 - (DOZER D8R)

A. *Assumed Load factor ……..Medium*
B. *Estimated fuel consumption……..33 Ltr/Hr*
C. *Fuel cost ……..….4.31 Birr/Ltr*
D. *Dozer Fuel Cost per hour* ***(DFC) = B*C***

↳ ***DFC = 142.23 Birr/Hr***

EXAMPLE 2 - (WHEEL LOADER 950G)

A. *Assumed Load factor ……..Medium*
B. *Estimated fuel consumption……...19 Ltr/Hr*
C. *Fuel cost ……4.31 Birr/Ltr*
D. *Loader Fuel Cost per hour* ***(LFC) = B * C***

↳ ***LFC = 81.89 Birr/Hr***

B – Cost of lube oils, filters and grease:

The cost of lubricants (lube oils), filters and grease will mainly depend on the maintenance practice of the equipment owner and conditions of the work location. Some equipment owners follow the equipment manufacturers' guideline concerning time periods between lube oils, filters and grease changes while others establish their own preventive maintenance guidelines.

Therefore, depending on the equipment owner's preventive maintenance schedule or the equipment manufacturer's service guideline, the cost of lube oils, filters and grease will be calculated based on the number of changes over the economic life of the equipment.

According to the manufacturer's guideline provided in the Caterpillar Performance Hand Book [26], the cost of lube oils, filters and grease for equipments in example 1 and 2 are calculated as follows:

B-1 – Cost of lube oils

Lube oils include lubricants required for Crankcase/Engine, Transmission, Final drives and Hydraulic control systems. Lube oil prices used in this computation are obtained from Shell Ethiopia during the month of November 2005.

EXAMPLE 1- (DOZER D8R)

A. *Estimated consumption of Engine oil……..…….0.129 Ltr/Hr*
B. *Price of Engine oil……...13.50 Birr/Ltr*
C. *Estimated consumption of Transmission oil……...0.144 Ltr/Hr*
D. *Price of Transmission oil……..……16.54 Birr/Ltr*
E. *Estimated consumption of Final drives oil……..…….0.015 Ltr/Hr*
F. *Price of Final drives oil…..……...14.81 Birr/Ltr*
G. *Estimated consumption of Hydraulic oil……....0.038 Ltr/Hr*
H. *Price of Hydraulic oil……..……..12.34 Birr/Ltr*
I. *Dozer Lube Oils Cost per hour* ***(DLOC) = A*B + C*D + E*F + G*H***

↳ ***DLOC = 4.81 Birr/Hr***

EXAMPLE 2 - (LOADER 950G)

A. *Estimated consumption of Engine oil……..…..0.120 Ltr/Hr*
B. *Price of Engine oil……..13.50 Birr/Ltr*
C. *Estimated consumption of Transmission oil……...0.034 Ltr/Hr*
D. *Price of Transmission oil……...……....16.54 Birr/Ltr*
E. *Estimated consumption of Final drives oil……..…...0.036 Ltr/Hr*
F. *Price of Final drives oil….……..14.81 Birr/Ltr*
G. *Estimated consumption of Hydraulic oil……..0.076 Ltr/Hr*
H. *Price of Hydraulic oil……...……....12.34 Birr/Ltr*
I. *Loader Lube Oils Cost per hour* ***(LLOC) = A*B + C*D + E*F + G*H***

↳ ***LLOC = 3.65 Birr/Hr***

B-2 – Cost of filters

Filter costs include the costs of Lube oil filters, Fuel filters and Air filters. The cost of filters depends entirely on the number of filter changes over a specified working time of the equipment. Filter prices used in this computation are obtained from Ries Engineering which is the Caterpillar dealer in Ethiopia during the month of November 2005.

EXAMPLE 1 - (DOZER D8R)

A. *Scheduled Engine oil filter changes ……..every 250 Hrs*
B. *Price of Engine oil filter……..317.10 Birr/Pc*
C. *Scheduled Transmission oil filter changes ……...every 500 Hrs*
D. *Price of Transmission oil filter……..449.92 Birr/Pc*
E. *Scheduled Hydraulic oil filter changes ……...every 500 Hrs*
F. *Price of Hydraulic oil filter……..802.33 Birr/Pc*
G. *Scheduled Primary fuel filter change ……..every 2000 Hrs*
H. *Price of Primary fuel filter……...71.94 Birr/Pc*
I. *Scheduled Final fuel filter change ……...every 500 Hrs*
J. *Price of Final fuel filter……....285.14 Birr/Pc*
K. *Scheduled Primary air filter change ……every 2000 Hrs*
L. *Price of Primary air filter……..1,075.64 Birr/Pc*
M. *Scheduled Secondary air filter change ……every 1000 Hrs*
N. *Price of Secondary air filter……1,021.37 Birr/Pc*

O. ***Dozer Cost of Filter per hour (DCF) = B/A + D/C + F/E + H/G + J/I + L/K + N/M***

↳ ***DCF = 5.94 Birr/Hr***

EXAMPLE 2 - (LOADER 950G)

A. *Scheduled Engine oil filter changes ……..every 250 Hrs*
B. *Price of Engine oil filter……149.01 Birr/Pc*
C. *Scheduled Transmission oil filter changes ……..every 500 Hrs*
D. *Price of Transmission oil filter……449.92 Birr/Pc*
E. *Scheduled Hydraulic oil filter changes ……..every 500 Hrs*
F. *Price of Hydraulic oil filter……1,260.65 Birr/Pc*
G. *Scheduled Primary fuel filter change ……every 2000 Hrs*
H. *Price of Primary fuel filter……208.13 Birr/Pc*
I. *Scheduled Final fuel filter change ……..every 500 Hrs*
J. *Price of Final fuel filter……..165.25 Birr/Pc*
K. *Scheduled Primary air filter change ……..…every 2000 Hrs*
L. *Price of Primary air filter……..…..809.54 Birr/Pc*
M. *Scheduled Secondary air filter change ……..…every 1000 Hrs*
N. *Price of Secondary air filter……...658.32 Birr/Pc*

O. *Loader Cost of Filter per hour (LCF) = B/A + D/C + F/E + H/G + J/I + L/K + N/M*

↳ ***LCF = 5.51 Birr/Hr***

B-3 – Cost of grease

The total consumption of grease depends on the size of the equipment, working environment of the equipment and the frequency of greasing by the equipment owner. [26] Even though very difficult in the absence of historical records, it can be assumed that on average one fitting may take about 0.02Kg as per recommendations from Ries Engineering which is the local dealer for Caterpillar products. Moreover, grease price used in this computation is obtained from Shell Ethiopia during the month of November 2005.

EXAMPLE 1 - (DOZER D8R)

A. *Estimated grease consumption……..……..0.006 Kg/Hr*
B. *Price of grease……...21.83 Birr/Kg*
C. *Dozer Grease Cost per hour* ***(DGC) = A*B***

↳ ***DGC = 0.13 Birr/Hr***

EXAMPLE 2 - (WHEEL LOADER 950G)

A. *Estimated grease consumption……..……..0.004 Kg/Hr*
B. *Price of grease……...21.83 Birr/Kg*
C. *Loader Grease Cost per hour* ***(LGC) = A*B***

↳ ***LGC = 0.09 Birr/Hr***

C – Cost of tires:

Cost of tires is one of the major operating costs for wheel mounted equipments. Tire costs include the cost of tire replacement and its repair. However, tire repair costs can be added to and treated with the remaining normal repair costs of the equipment i.e. equipment repair costs which are not included in the cost of major repairs and overhauls.

It is actually difficult to estimate tire economic life because of the tire wear variability depending on the site surface conditions, speed, wheel position, working load, maintenance conditions, road grades and curves as well as operator's skill. The best way to estimate tire economic life is to use the equipment owner's tire utilization records for each type of equipment. In the absence of such accurate records, it is better to use tire economic life guide lines prepared both by the equipment and tire manufacturers. [26]

As provided in the Caterpillar Performance Hand Book [26], the economic life of tires is categorized into three zones based on the working applications.

A. **Zone A**: Almost all tires actually wear through the tread from abrasion.

B. **Zone B**: Tires wear out normally but others fail prematurely due to rock cuts, impacts and non-repairable punctures.

C. **Zone C**: Few, if any, tires wear through the tread due to non-repairable damages, usually from rock cuts, impacts and continuous overloading.

In addition to the economic life of tires, the local market tire prices are also important to determine the hourly cost of tires. For the purpose of this tire cost computation, tire unit prices are collected from Sur Construction Plc and Ethiopian Roads Authority purchase records between year 2002 and 2006 for the earthmoving equipments shown in Table 8-2.

Table 8-2 – TIRE UNIT PRICE IN BIRR

ITEM NO	TYPE OF EQUIPMENT	TIRE UNIT PRICE	TOTAL QUANTITY OF TIRES REQUIRED	REMARK
1	Wheel Loader	14,115.22	4	Sur construction purchase records
2	Backhoe Loader	8,810.80	4	Sur construction purchase records
3	Grader	5,316.00	6	Sur construction purchase records
4	Wheel Tractor – Scraper	9,100.00	4	ERA purchase records
5	Vibratory Roller	8,608.00	2	Sur construction purchase records

EXAMPLE 1 – (DOZER D8R)

A. *Dozer Tire Cost per hour* ***(DTC) = 0.00 Birr/Hr (Crawler Mounted)***

   - ***DTC = 0.00 Birr/Hr***

EXAMPLE 2 – (LOADER 950G)

A. *Cost of tire ……..14,115.22 Birr/Pc*
B. *Number of tires required for one set……...4*
C. *Estimated economic life……...2,200 Hrs*
D. *Loader Tire Cost per hour* ***(LTC) = (A*B)/C***

   - ***LTC = 25.66 Birr/Hr***

D – Cost of undercarriage:

Undercarriage maintenance cost is one of the major operating costs for crawler mounted equipments. The undercarriage can be employed in an extremely abrasive and high-wear environment while the basic equipment may be in an easy application and vice versa. Due to this reason it is recommended to calculate the cost of undercarriage maintenance separately from the normal equipment repair costs.

As stated in the Caterpillar Performance Hand Book [26], the three main parameters which affect the equipment undercarriage costs are:

A. **Impact:-** The most measurable effect of impact is structural bending, chipping, cracking, spalling, roll-over and etc. The effects of impact are rated as high, medium and low.

B. **Abrasiveness:-** The tendency of the underfoot materials to grind away the wear surfaces of the track components. The effects of abrasiveness are also rated as high, medium and low.

C. **Z factor:-** It represents the combined effect on undercarriage component life due to environmental and terrain conditions such as working on salty soil, maintenance conditions which definitely affects the life span of components and operation conditions which entirely depends on the operator's skill. Moreover, it is estimated that Z factor will affected about 50% by maintenance conditions, 30% by environment and terrain conditions and the remaining 20% by operation conditions.

After identifying the impact, abrasiveness and Z factor, the hourly cost of undercarriage can be calculated using the cost estimating tables provided by the equipment manufacturer's as given in the Caterpillar Performance Hand Book. [26] The hourly cost of undercarriage calculated using these cost estimating tables assumes about 70% to be cost of parts and the remaining 30% goes to labor cost.

However, the labor cost portion of the undercarriage cost indicated in the Caterpillar Performance Handbook considers the estimated labor cost in the United States which is very high as compared to the local labor cost in Ethiopia. Therefore, only one fourth of the labor cost portion given in the Caterpillar Performance Handbook is used in calculating undercarriage costs of the equipments in example 1 and 2 as computed below:

EXAMPLE 1 – (DOZER D8R)

A. *Basic factor……..8.5 USD/Hr*
B. *Assumed impact……Moderate (0.2 condition multiplier)*
C. *Assumed Abrasiveness……..Moderate (0.2 condition multiplier)*
D. *Assumed Z factor……Moderate (0.5 condition multiplier)*
E. *Dozer Undercarriage Cost per hour* ***(DUC) =*** *0.7*A*(B+C+D) + 0.25*0.3*A*(B+C+D)*

⇨ *DUC = 5.93 USD/Hr*
⇨ *Using the selling rate of the commercial bank of Ethiopia as of November 15, 2005 i.e. 1 USD = 8.8506 Birr*

⇨ ***DUC = 52.48 Birr/Hr***

EXAMPLE 2 – (LOADER 950G)

A. *Loader Undercarriage Cost per hour* ***(LUC) ……****Zero (wheel mounted)*

⇨ ***LUC = 0.00 Birr/Hr***

E – Cost of normal repairs:

Normal repairs are all these repairs to be carried out during the economic life time of the equipment excluding the undercarriage maintenance as well as major repairs and overhauls. Normal repair costs are actually one of the largest operating costs of equipments. Accurate estimated cost of normal repairs can be obtained from previous records of the equipment owner. However, in the absence of such accurate data, the equipment manufacturers' guideline can be used to estimate the hourly equipment cost of normal repairs. [26]

In the Caterpillar Performance Hand Book, the hourly normal repair costs are calculated using the basic repair factor from charts provided based on the work application of the equipment which are rated as Zone A (moderate), Zone B (average) and Zone C (Severe). Moreover, extended-life multipliers will be used if the estimated economic life of the equipment is greater than 10,000 Hrs and these extended-life multipliers are given for each equipment depending on their economic life.

The cost of normal repairs provided in the Caterpillar Handbook includes the cost of parts and labor. Same as that of the hourly cost of undercarriage, only one fourth of the labor cost is considered in calculating the hourly normal cost of repairs for the equipments in example 1 and 2.

EXAMPLE 1 – (DOZER D8R)

A. *Work application……..…….Zone B (Average)*
B. *Basic repair factor……..7.5 USD/Hr*
C. *Estimated economic life……..20,000 Hrs*
D. *Extended life multiplier……1.3*
E. *Hourly normal repair cost of parts = 0.7*B*D*
F. *Hourly normal repair cost of labor = 0.25*0.3*B*D*
G. *Dozer Normal Repair Cost per hour* ***(DNRC) = E + F***

- ⇨ *DNRC = 7.55625 USD/Hr*
- ⇨ *Using the selling rate of the commercial bank of Ethiopia as of November 15, 2005 i.e. 1 USD = 8.8506 Birr*

- ⇨ ***DNRC = 66.88 Birr/Hr***

EXAMPLE 2 – (LOADER 950G)

A. *Work application……..…….Zone B (Average)*
B. *Basic repair factor……..4.5 USD/Hr*
C. *Estimated economic life……10,000 Hrs*
D. *Extended life multiplier……1.0*
E. *Hourly normal repair cost of parts = 0.6*B*D*
F. *Hourly normal repair cost of labor = 0.25*0.4*B*D*
G. *Loader Normal Repair Cost per hour* ***(LNRC) = E + F***

- ⇨ *LNRC = 3.15 USD/Hr*

- ⇨ ***LNRC = 27.88 Birr/Hr***

F – Cost of high wear items:

High wear items are these items having very short economic life as compared to the basic equipment. These items are usually called ground engaging tools which are different in size and economic life depending on the type of equipment and work application. Some of these items include cutting edges, ripper tips, bucket teeth, body liners, cables, router bits and so on.

The consumption of high wear items vary widely depending on work applications, materials to be handled, type of material where the ground engaging tools are made and operating techniques. The consumption and cost of high wear items can be obtained mainly from previous records of equipment owners. However, in the absence of such data it is better to consult equipment manufacturers and suppliers for consumption estimates.

These high wear items may or may not be used all the time when the equipment is working such as a dozer ripper will be used only when the dozer is ripping. Therefore, in calculating the hourly cost of high wear items the time factor shall be considered properly as illustrated with the following example.

Assume a dozer is ripping 30% of its working time and the estimated economic life of the ripper is 50 Hours. Moreover, the ripper is purchased for Birr 500. Establish the hourly cost of the ripper.

A. Economic life of ripper as compared with the dozer operating time

⇨ *50/0.3 = 167 Hr*

B. Hourly cost of ripper

⇨ *500/167 = 2.99 Birr/Hr*

Actually it is very difficult to get accurate estimates of high wear items economic life and unfortunately even the Caterpillar Performance Handbook does not provide such cost estimate guideline data. Therefore, contractors are strongly advised to keep proper records of high wear items consumption for each type of equipment. For the purpose of this exercise, let's assume the cost of high wear items per hour to be 1.32USD/Hr for Bulldozer and 0.6USD/Hr for Wheel loader.

EXAMPLE 1 – (DOZER D8R)

⇨ *Dozer High Wear Items Cost per hour (DHWIC) = 1.32 USD/Hr*
⇨ *DHWIC = 1.32*8.8506*

⇨ ***DHWIC = 11.68 Birr/Hr***

EXAMPLE 2 – (LOADER 950G)

- ⇨ *Dozer High Wear Items Cost per hour (DHWIC) = 0.60 USD/Hr*
- ⇨ *LHWIC = 0.60*8.8506*

- ⇨ ***LHWIC = 5.31 Birr/Hr***

G – Summarized operating costs of equipment:

As discussed earlier, the equipment operating cost includes the cost of fuel, lubricants, filters, grease, tires, undercarriage, normal repairs and high wear items and all these costs will be summed to get the operating cost of the equipment. Accordingly, the operating cost of equipments given in example 1 and 2 are calculated as follows:

EXAMPLE 1 – (DOZER D8R)

- ⇨ *Hourly operating costs = DFC + DLOC + DCF + DGC + DTC + DUC + DNRC + DHWIC*
- ⇨ *Hourly operating costs = 142.23 + 4.81 + 5.94 + 0.13 + 0.00 + 52.48 + 66.88 + 11.68*

- ⇨ ***Hourly operating costs = 284.15 Birr/Hr***

EXAMPLE 2 – (LOADER 950G)

- ⇨ *Hourly operating costs = LFC + LLOC + LCF + LGC + LTC + LUC + LNRC + LHWIC*
- ⇨ *Hourly operating costs = 81.89 + 3.65 + 5.51 + 0.09 + 25.66 + 0.00 + 27.88 + 5.31*

- ⇨ ***Hourly operating costs = 149.99 Birr/Hr***

8-3 – OPERATOR'S SALARY AND BENEFITS

Based on the earlier discussions under the direct labor hourly cost estimation, the annual operator's salary and benefits shall be summed up and divided by the annual utilization of the equipment to get the hourly cost of operators. In determining the annual operator's salary and benefits, the following costs, but not limited to, shall be assessed properly.

- ✓ Basic salary
- ✓ Hardship allowance
- ✓ Project allowance
- ✓ Food allowance
- ✓ Overtime pay
- ✓ Insurance
- ✓ Bonus
- ✓ Provident fund
- ✓ Severance pay
- ✓ Annual leave pay
- ✓ Collective agreements

As an example, let's see how to estimate the hourly cost of dozer and loader operators based on the following assumptions as summarized under Table 8-3.

- ✓ *Project location……..…..Humera*
- ✓ *Project type……..…..Road*
- ✓ *Project duration……2 years*
- ✓ *Project daily working hours…….....10hr per day*
- ✓ *Working days in a year……...313 days*
- ✓ *Rest days……..…Sundays*
- ✓ *Dozer operator's basic salary……....2000 Birr/month*
- ✓ *Loader operator's basic salary……..1500 Birr/month*
- ✓ *Project allowance……40% of monthly salary*
- ✓ *Hardship allowance……30% of monthly salary*
- ✓ *Food allowance……120 Birr/month*
- ✓ *Bonuses……....Two month salary per year*
- ✓ *Provident fund……..10% monthly salary*
- ✓ *Medical insurance……..…1.5% of annual salary*
- ✓ *Annual leave……....20 working days for the first year*

Table 8-3 – Operator's annual salary and benefits cost breakdown

SALARY AND BENEFITS		OPERATOR BY EQUIPMENT		CLARIFICATIONS AND REMARKS
		Dozer	Wheel Loader	
A	Basic salary	24,000.00	18,000.00	12 x Monthly basic salary
B	Overtime pay	7,500.00	5,625.00	313 x 2 = 626 hours/year
C	Project allowance	9,600.00	7,200.00	40% (A)
D	Hardship allowance	7,200.00	5,400.00	30% (A)
E	Food allowance	1,440.00	1,440.00	120 x Twelve months
F	Medical insurance	360.00	270.00	1.5% (A)
G	Bonus	4,000.00	3,000.00	2 x Monthly basic salary
H	Provident fund	2,400.00	1,800.00	10% (A)
I	Annual leave	3,143.77	2,357.83	20 + 21 = 41 working days
J	Severance pay	2,666.67	2,000.00	(1 + 1/3) months
Total annual salary and benefits		**62,310.44**	**47,092.83**	**A+B+C+D+E+F+G+H+I+J**

Once, the annual salary and benefits are calculated for the equipment operators, the hourly cost of operators for the equipments in example 1 and 2 are computed as follows:

EXAMPLE 1 – (DOZER D8R)

A. *Total annual salary and benefits…….…….. 62,310.44 Birr*
B. *Annual equipment utilization……2000 Hrs*
C. *Hourly operator's cost* ***= A/B***

↳ ***Hourly operator's cost = 31.16 Birr/Hr***

EXAMPLE 2 – (LOADER 950G)

A. *Total annual cost of operator's wage and benefits…….. 47,092.83 Birr*
B. *Annual equipment utilization……1,250 Hrs*
C. *Hourly operator's costs* ***= A/B***

↳ ***Hourly operator's costs = 37.67 Birr/Hr***

The equipment hourly cost for owned equipments is then the sum of the equipment owning costs, equipment operating costs and the operator's salary and benefits. Therefore, a contractor has to use the following hourly equipment costs for the earthmoving equipment in example 1 and 2 as the equipment hourly cost in his cost estimations.

EXAMPLE 1 – (DOZER D8R)

A. *Hourly owning costs…….…….. 288.21 Birr*
B. *Hourly operating costs……284.15 Birr*
C. *Hourly operator's costs……..31.16 Birr*
D. ***Hourly Bulldozer costs = A + B + C***

↳ ***Hourly Bulldozer costs = 603.52 Birr***

EXAMPLE 2 – (LOADER 950G)

A. *Hourly owning costs…….…….. 237.44 Birr*
B. *Hourly operating costs……149.99 Birr*
C. *Hourly operator's cost……..37.67 Birr*
D. ***Hourly Loader cost = A + B + C***

↳ ***Hourly Loader cost = 425.10 Birr***

There are also cases where contractors may lease their equipments to other construction companies. Therefore, contractors and leasing companies are also interested to establish their equipment rental rates from time to time. In establishing these equipment rental rates, in addition to the equipment owning costs, equipment operating costs and operator's costs, contractors and equipment leasing companies need to understand the following cost components and include any additional costs to establish their equipment rental rates.

- ⇨ Overhead costs
- ⇨ Breakeven costs
- ⇨ Profit and income tax
- ⇨ Equipment rental rates

8-4 – OVERHEAD COSTS

In addition to the Equipment owning and operating costs as well as cost of operators, the equipment owner's overhead costs shall be included in determining the overall equipment hourly costs. Overhead costs widely vary between equipment owners depending on organizational structure, number of staffs employed at head office and project sites, salary and benefit scales, office facilities and so on.

Overhead costs are major costs to the equipment owners and obviously need proper survey of these costs. Overhead costs may include, but not limited to, the following items:

- ✓ Labor cost of marketing, finance, supply, technical and administration teams working both at the head office and project sites
- ✓ Garages, workshops and warehouses
- ✓ Head office building depreciation or renting costs
- ✓ Cost of project camp facilities
- ✓ Head office and project office running costs such as desks, chairs, computers, telephone, fax, internet, stationery and so on
- ✓ Cost of equipment mobilization and demobilization
- ✓ Cost of small vehicles and so on

Even though, the principles of estimating overhead costs will be covered in detail under chapter 9, let's assume the equipment owner has an overhead cost amounting 15% of the sum of Equipment owning costs, operating costs and operator's costs. [25]

EXAMPLE 1 – (DOZER D8R)

A. Hourly owning costs = 288.21 Birr
B. Hourly operating costs = 284.15 Birr
C. Hourly operator's costs = 31.16 Birr
D. Hourly overhead costs ***= 0.15*(A+B+C)***
↳ ***Hourly overhead costs = 90.53 Birr***

EXAMPLE 2 – (LOADER 950G)

A. *Hourly owning costs = 237.44 Birr*
B. *Hourly operating costs = 149.99 Birr*
C. *Hourly operator's cost = 37.67 Birr*
D. *Hourly overhead costs* ***= 0.15*(A+B+C)***

↳ ***Hourly overhead costs = 63.77 Birr***

8-5 – EQUIPMENT BREAKEVEN COST

Equipment breakeven cost is the sum of equipment owning costs, operating costs, operator's costs and overhead costs. Accordingly, the hourly breakeven costs for the equipments in example 1 and 2 are computed as follows.

EXAMPLE 1 – (DOZER D8R)

A. *Hourly owning costs = 288.21 Birr*
B. *Hourly operating costs = 284.15 Birr*
C. *Hourly operator's costs = 31.16 Birr*
D. *Hourly overhead costs = 90.53 Birr*
E. *Hourly breakeven costs =* ***A + B + C + D***

↳ ***Hourly breakeven costs = 694.05 Birr***

EXAMPLE 2 – (LOADER 950G)

A. *Hourly owning costs = 237.44 Birr*
B. *Hourly operating costs = 149.99 Birr*
C. *Hourly operator's cost = 37.67 Birr*
D. *Hourly overhead costs = 63.77 Birr*
E. *Hourly breakeven costs =* ***A + B + C + D***

↳ ***Hourly breakeven costs = 488.87 Birr***

8-6 – PROFIT AND INCOME TAX

Obviously equipment owners are investing their capital to get maximum possible profit from the contracts to be performed. The profit margin depends entirely on the market competitiveness and company strategies. Moreover, any equipment leasing company operating a profitable business in Ethiopia shall pay 30% of its gross profit as income tax as per the Income tax proclamation No. 286/2002. [41]

For completeness of the exercise in establishing the equipment rental cost of the equipments in example 1 and 2, assume the net profit margin to be 10% of the equipment breakeven cost. Accordingly, gross profit has to be calculated and added to the equipment breakeven cost to establish the rental rate of equipments.

- → Let **C** be the equipment breakeven cost
- → Gross Profit = X% * C
- → Net Profit = 10% * C
- → Income tax = 0.3 * Gross profit
- → Gross Profit = Net Profit + Income tax
- → X% * C = 10% * C + 0.3 * X% * C
- → X% = 10% + 0.3 * X%

    - ↳ **X% = 14.29%**

EXAMPLE 1 – (DOZER D8R)

A. *Hourly breakeven costs = 694.05 Birr*
B. *Hourly gross profit = **0.1429*A***

    - ↳ ***Hourly gross profit = 99.18 Birr***

EXAMPLE 2 – (LOADER 950G)

A. *Hourly breakeven costs = 488.87 Birr*
B. *Hourly gross profit = **0.1429*A***

    - ↳ ***Hourly gross profit = 69.86 Birr***

8-7 – EQUIPMENT RENTAL RATES

If the equipment owner wants to rent his equipment to others, equipment rental rates shall be calculated when the equipment is running and in its idle situation. Running equipment rental rate includes the breakeven costs plus the gross profit. While idle equipment rental rate includes only the equipment owning costs, operator's costs and overhead costs.

Therefore, contractors or equipment leasing companies can easily determine the rental rates of their equipments as far as the following hourly costs are properly calculated for each equipment.

- ✓ Equipment hourly owning costs
- ✓ Equipment hourly operating costs
- ✓ Operator's hourly costs
- ✓ Overhead hourly costs
- ✓ Hourly gross profit
- ✓ Hourly breakeven costs

As an illustration, let's demonstrate to calculate the equipment idle rental rate and the equipment running rental rate for both the earthmoving equipments under example 1 and 2.

EXAMPLE 1 – (DOZER D8R)

- ***Dozer Idle Rental Rate per hour***

  A. *Hourly owning costs = 288.21 Birr*
  B. *Hourly operator's costs = 31.16 Birr*
  C. *Hourly overhead costs = 90.53 Birr*

  ↳ ***Hourly idle dozer rental rate = 409.90 Birr***

- ***Dozer Running Rental Rate per hour***

  A. *Hourly breakeven costs = 694.05 Birr*
  B. *Hourly gross profit = 99.18 Birr*

  ↳ ***Hourly running dozer rental rate = 793.23 Birr***

EXAMPLE 2 – (LOADER 950G)

- ***Loader Idle Rental Rate per hour***

  A. *Hourly owning costs = 237.44 Birr*
  B. *Hourly operator's costs = 37.67 Birr*
  C. *Hourly overhead costs = 63.77 Birr*

  ↳ ***Hourly idle loader rental rate = 338.88 Birr***

- ***Loader Running Rental Rate per hour***

  A. *Hourly breakeven costs = 488.87 Birr*
  B. *Hourly gross profit = 69.86 Birr*

  ↳ ***Hourly running loader rental rate = 558.73 Birr***

In calculating the hourly cost and rental rates of equipments, contractors and leasing companies need not to work all the detail calculation for every equipment in a such time taking manner but rather adapt appropriate formats which can be friendly to use and able to calculate all these detailed cost breakdowns. As an illustration, the hourly cost and rental rates of the crawler mounted dozer D8R and wheel loader 950G in the above examples are summarized under Table 8-4.

TABLE 8-4 – HOURLY EQUIPMENT COST BREAKDOWN FOR CATERPILLAR CRAWLER MOUNTED D8R DOZER AND 950 G WHEEL LOADER				
ITEM NO	**DESCRIPTION**	**TYPE OF EQUIPMENT**		**CALCULATION AND CLARIFICATION**
		DOZER – D8R	**LOADER - 950G**	
A	Equipment delivered price without VAT	3,871,739.13	1,785,478.26	Data
B	Cost of tires without VAT	0.00	56,460.88	Data
C	Equipment delivered price less tire cost	3,871,739.13	1,729,017.38	A - B
D	Estimated economic life in years	10.00	8.00	Data
E	Estimated annual utilization in hours	2,000.00	1,250.00	Data
F	Estimated salvage value	387,173.91	178,547.83	10% * A
G	Equivalent annual delivered price less tire cost	564,057.91	295,189.99	C * (0.075*1.075^D) / (1.075^D - 1)
H	Equivalent annual salvage value	27,367.75	17,091.85	F * 0.075 / (1.075^D - 1)
I	**Hourly depreciation cost**	**268.35**	**222.48**	**(G - H) / E**
J	Annual insurance charges	38,717.39	17,854.78	1% * A
K	**Hourly insurance charges**	**19.36**	**14.28**	**J/E**
L	Property tax every two years	2,000.00	1,700.00	Data
M	**Hourly property tax**	**0.50**	**0.68**	**L / (2*E)**
N	**HOURLY OWNERSHIP COST**	**288.21**	**237.44**	**I + K + M**
O	Estimated fuel consumption (Ltr/Hr)	33.00	19.00	Data
P	Fuel cost per litre	4.31	4.31	Data
Q	**Hourly fuel cost**	**142.23**	**81.89**	**O * P**
R	Estimated engine oil consumption (Ltr/Hr)	0.129	0.120	Data
S	Engine oil cost per litre	13.50	13.50	Data
T	**Hourly cost of engine oil**	**1.74**	**1.62**	**R * S**
U	Estimated transmission oil consumption (Ltr/Hr)	0.144	0.034	Data
V	Transmission oil cost per litre	16.54	16.54	Data
W	**Hourly cost of transmission oil**	**2.38**	**0.56**	**U * V**

TABLE 8-4 (Continued) – HOURLY EQUIPMENT COST BREAKDOWN FOR CATERPILLAR CRAWLER MOUNTED D8R DOZER AND 950 G WHEEL LOADER				
ITEM NO	**DESCRIPTION**	**TYPE OF EQUIPMENT**		**CALCULATION AND CLARIFICATION**
		DOZER – D8R	**LOADER - 950G**	
X	Estimated final drives oil consumption (Ltr/Hr)	0.015	0.036	Data
Y	Final drives oil cost per litre	14.81	14.81	Data
Z	**Hourly cost of final drives oil**	**0.22**	**0.53**	**X * Y**
AA	Estimated hydraulic oil consumption (Ltr/Hr)	0.038	0.076	Data
AB	Hydraulic oil cost per litre	12.34	12.34	Data
AC	**Hourly cost of hydraulic oil**	**0.47**	**0.94**	**AA * AB**
AD	Estimated grease consumption (Kg/Hr)	0.006	0.004	Data
AE	Grease cost per Kg	21.83	21.83	Data
AF	**Hourly cost of grease**	**0.13**	**0.09**	**AD * AE**
AG	Scheduled engine oil filter changes (Hrs)	250.00	250.00	Data
AH	Engine oil filter cost	317.10	149.01	Data
AI	**Hourly cost of engine oil filter**	**1.27**	**0.60**	**AH / AG**
AJ	Scheduled transmission oil filter changes (Hrs)	500.00	500.00	Data
AK	Transmission oil filter cost	449.92	449.92	Data
AL	**Hourly cost of engine oil filter**	**0.90**	**0.90**	**AK / AJ**
AM	Scheduled hydraulic oil filter changes (Hrs)	500.00	500.00	Data
AN	Hydraulic oil filter cost	802.33	1,260.65	Data
AO	**Hourly cost of hydraulic oil filter**	**1.60**	**2.52**	**AN / AM**
AP	Scheduled primary fuel filter changes (Hrs)	2,000.00	2,000.00	Data
AQ	Primary fuel filter cost	71.94	208.13	Data
AR	**Hourly cost of primary fuel filter**	**0.04**	**0.10**	**AQ / AP**
AS	Scheduled final fuel filter changes (Hrs)	500.00	500.00	Data
AT	Final fuel filter cost	285.14	165.25	Data
AU	**Hourly cost of final fuel filter**	**0.57**	**0.33**	**AT / AS**

TABLE 8-4 – (Continued) HOURLY EQUIPMENT COST BREAKDOWN FOR CATERPILLAR CRAWLER MOUNTED D8R DOZER AND 950 G WHEEL LOADER

ITEM NO	DESCRIPTION	TYPE OF EQUIPMENT		CALCULATION AND CLARIFICATION
		DOZER – D8R	LOADER - 950G	
AV	Scheduled primary air filter changes (Hrs)	2,000.00	2,000.00	Data
AW	Primary air filter cost	1,075.64	809.54	Data
AX	**Hourly cost of primary air filter**	**0.54**	**0.40**	**AW / AV**
AY	Scheduled secondary air filter changes (Hrs)	1,000.00	1,000.00	Data
AZ	Secondary air filter cost	1,021.37	658.32	Data
BA	**Hourly cost of final fuel filter**	**1.02**	**0.66**	**AZ / AY**
BB	Economic life of tires in hours	0.00	2,200.00	Data
BC	**Hourly cost of tires**	**0.00**	**25.66**	**B / BB**
BD	**Hourly cost of undercarriage**	**52.48**	**0.00**	**Data**
BE	**Hourly cost of normal repairs**	**66.88**	**27.88**	**Data**
BF	**Hourly cost of high wear items**	**11.68**	**5.31**	**Data**
BG	**HOURLY OPERATING COST**	**284.15**	**149.99**	**Q+T+W+Z+AC+AF+AI+AL+AO+AR+AU+AX+BA+BC+BD+BE+BF**
BH	Annual operator's cost	62,310.44	47,092.83	Data
BI	**HOURLY OPERATOR'S COST**	**31.16**	**37.67**	**BH / E**
BJ	**HOURLY OVERHEAD COST**	**90.53**	**63.77**	**15% * (N+BG+BI)**
BK	**HOURLY GROSS PROFIT**	**99.18**	**69.86**	**14.29% * (N+BG+BI+BJ)**
BL	**HOURLY EQUIPMENT BREAKEVEN COST**	**694.05**	**488.87**	**N + BG + BI + BJ**
BM	**HOURLY IDLE EQUIPMENT RENTAL RATE**	**409.90**	**338.88**	**N + BI + BJ**
BN	**HOURLY RUNNING EQUIPMENT RENTAL RATE**	**793.23**	**558.73**	**BL + BK**

9 – INDIRECT COST ESTIMATION

As discussed under chapter 3, indirect construction costs are all costs, which can not be directly booked under a specific activity in a construction project but rather required to keep the whole project operational. These costs are mainly categorized as the Head office overhead costs and the site overhead costs.

9-1 – HEAD OFFICE OVERHEAD COST ESTIMATION

Construction firms usually have their head office at the capital cities of different regional states where contractors consider appropriate to manage their projects. Head office overhead costs are all costs required to run the whole operation of the construction company which usually administers different projects at a time. These costs are not usually associated with specific project but rather shared proportionally by all projects under the company.

As discussed under chapter 5, in estimating the construction unit costs of an activity, head office overhead costs are expressed as a percentage of the direct unit cost of each activity. Therefore, it is better to calculate the annual head office overhead costs and shared these costs by the annual direct cost turnover of all the projects running by the contractor.

In order to demonstrate on how to establish head office overhead costs of construction firms, let's focus mainly on the following head office expenses and try to establish the head office overhead costs for a GC1 contractor using different assumptions.

- ✓ Head office staff costs
- ✓ Small vehicle transportation expenses
- ✓ Travel expenses
- ✓ Building costs
- ✓ Bidding expenses
- ✓ Office furniture and equipment expenses
- ✓ Office running expenses
- ✓ Sundry expenses

A – Annual Head office staff costs:

The annual head office staff cost mainly depends on the organizational structure which reflects the number of staffs required and the salary and benefits scale of the company which in turn reflects the cost associated with each staff.

As an example, let's consider a GC1 contractor having his head office in Addis with the following organizational structure as shown in chart 9-1 and calculate the annual head office staff costs of this construction firm. Moreover, to make complete exercise of the annual head office staff cost calculations, estimated number of staffs, salary and benefit scales in each department are assumed as shown in Table 9-2.

CHART 9-1 - SAMPLE ORGANIZATIONAL CHART

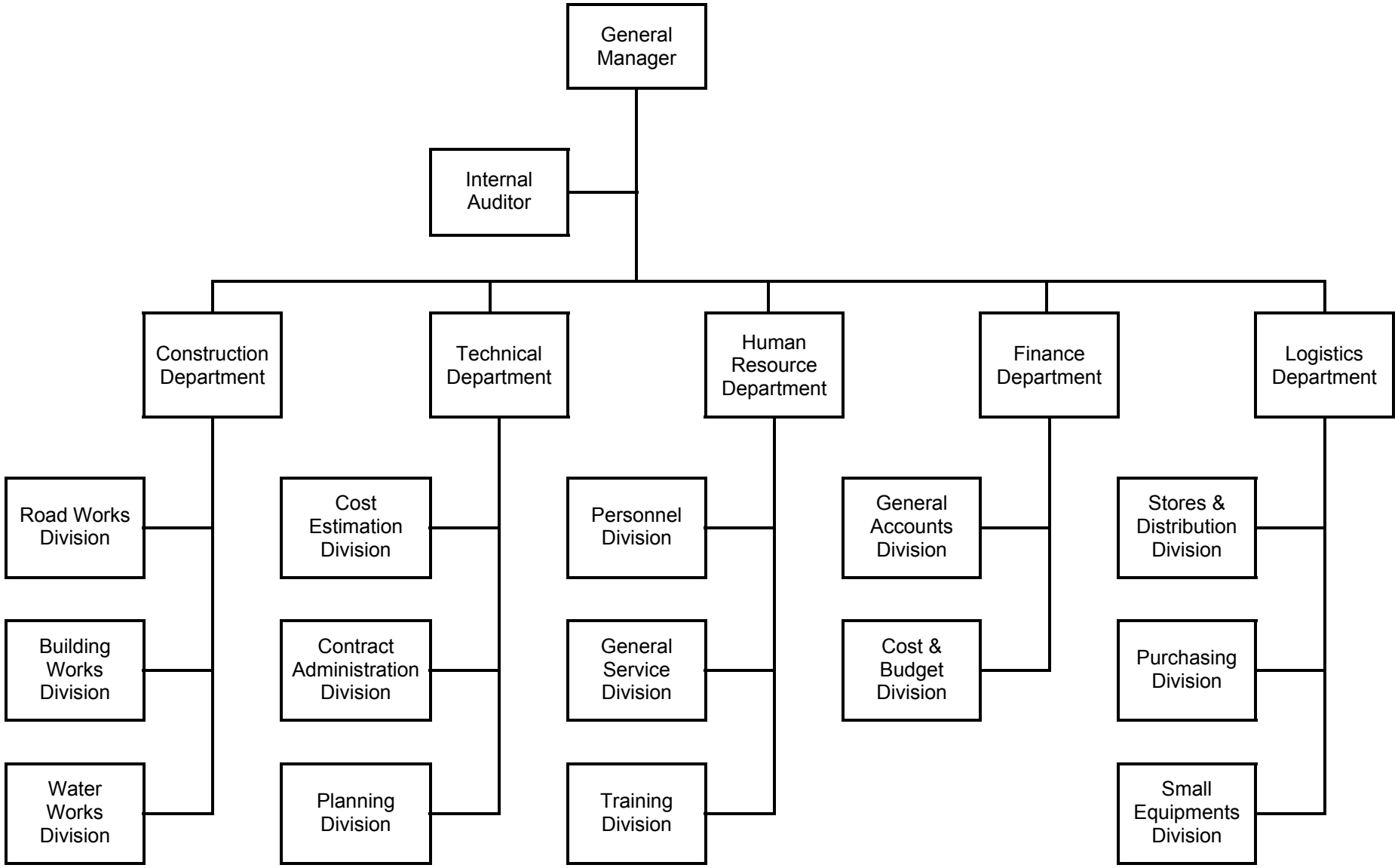

Table 9-2 – General Manager and Auditor's Office staff Annual Cost in Birr

NUMBER OF STAFFS, SALARY AND BENEFITS		GENERAL MANAGER	AUDITOR	SECRETARY	DRIVERS	REMARK
A	Number of staff	1	1	1	1	Estimated
B	Annual basic salary	120,000.00	36,000.00	14,400.00	9,600.00	12 * Monthly basic salary
C	Annual responsibility allowance	60,000.00	_	_	_	Estimated
D	Annual bonus	20,000.00	6,000.00	2,400.00	1,600.00	Two months salary per year
E	Annual provident fund	12,000.00	3,600.00	1,440.00	960.00	10% (Basic salary)
F	Annual medical insurance	1,800.00	540.00	216.00	144.00	1.5% (Basic salary)
G	Annual leave	10,000.00	3,000.00	1,200.00	800.00	Monthly salary /Estimated/
H	Annual severance pay	5,000.00	1,500.00	600.00	400.00	Half month salary /Estimated/
ANNUAL GM AND AUDITOR'S OFFICE STAFF COSTS		**228,800.00**	**50,640.00**	**20,256.00**	**13,504.00**	**313,200.00**

Table 9-2 (Continued) – Construction Department staff Annual cost in Birr

NUMBER OF STAFFS, SALARY AND BENEFITS		DEPARTMENT HEAD	DIVISION HEADS	JUNIOR ENGINEERS	SECRETARY	DRIVERS	REMARK
A	Number of staff	1	3	3	1	2	Estimated
B	Annual basic salary	60,000.00	36,000.00	24,000.00	9,600.00	7,200.00	12 * Monthly basic salary
C	Annual responsibility allowance	36,000.00	24,000.00	_	_	_	Estimated
D	Annual bonus	10,000.00	6,000.00	4,000.00	1,600.00	1,200.00	Two months salary per year
E	Annual provident fund	6,000.00	3,600.00	2,400.00	960.00	720.00	10% (Basic salary)
F	Annual medical insurance	900.00	540.00	360.00	144.00	108.00	1.5% (Basic salary)
G	Annual leave	5,000.00	3,000.00	2,000.00	800.00	600.00	Monthly salary /Estimated/
H	Annual severance pay	2,500.00	1,500.00	1,000.00	400.00	300.00	Half month salary /Estimated/
ANNUAL CONSTRUCTION DEPARTMENT STAFF COSTS		**120,400.00**	**223,920.00**	**101,280.00**	**13,504.00**	**20,256.00**	**479,360.00**

Table 9-2 (Continued) – Technical Department staff Annual cost in Birr

NUMBER OF STAFFS, SALARY AND BENEFITS		DEPARTMENT HEAD	DIVISION HEADS	JUNIOR ENGINEERS	SECRETARY	DRIVERS	REMARK
A	Number of staff	1	3	3	1	2	Estimated
B	Annual basic salary	60,000.00	36,000.00	24,000.00	9,600.00	7,200.00	12 * Monthly basic salary
C	Annual responsibility allowance	36,000.00	24,000.00	_	_	_	Estimated
D	Annual bonus	10,000.00	6,000.00	4,000.00	1,600.00	1,200.00	Two months salary per year
E	Annual provident fund	6,000.00	3,600.00	2,400.00	960.00	720.00	10% (Basic salary)
F	Annual medical insurance	900.00	540.00	360.00	144.00	108.00	1.5% (Basic salary)
G	Annual leave	5,000.00	3,000.00	2,000.00	800.00	600.00	Monthly salary /Estimated/
H	Annual severance pay	2,500.00	1,500.00	1,000.00	400.00	300.00	Half month salary /Estimated/
ANNUAL TECHNICAL DEPARTMENT STAFF COSTS		**120,400.00**	**223,920.00**	**101,280.00**	**13,504.00**	**20,256.00**	**479,360.00**

Table 9-2 (Continued) – Human Resource Department staff Annual cost in Birr

NUMBER OF STAFFS, SALARY AND BENEFITS		DEPARTMENT HEAD	DIVISION HEADS	CLERKS	SECRETARY	DRIVERS	CLEANERS	GUARDS	REMARK
A	Number of staff	1	3	6	1	2	4	4	
B	Annual basic salary	36,000.00	24,000.00	12,000.00	9,600.00	7,200.00	3,600.00	3,600.00	
C	Annual responsibility allowance	24,000.00	6,000.00	_	_	_	_	_	
D	Annual bonus	6,000.00	4,000.00	2,000.00	1,600.00	1,200.00	600.00	600.00	Same as above
E	Annual provident fund	3,600.00	2,400.00	1,200.00	960.00	720.00	360.00	360.00	
F	Annual medical insurance	540.00	360.00	180.00	144.00	108.00	54.00	54.00	
G	Annual leave	3,000.00	2,000.00	1,000.00	800.00	600.00	300.00	300.00	
H	Annual severance pay	1,500.00	1,000.00	500.00	400.00	300.00	150.00	150.00	
ANNUAL HR DEPARTMENT STAFF COSTS		**74,640.00**	**119,280.00**	**101,280.00**	**13,504.00**	**20,256.00**	**20,256.00**	**20,256.00**	**369,472.00**

Table 9-2 (Continued) – Finance Department staff Annual cost in Birr

NUMBER OF STAFFS, SALARY AND BENEFITS		DEPARTMENT HEAD	DIVISION HEADS	CLERKS	SECRETARY	DRIVERS	REMARKS
A	Number of staff	1	2	6	1	2	Estimated
B	Annual basic salary	36,000.00	24,000.00	12,000.00	9,600.00	7,200.00	12 * Monthly basic salary
C	Annual responsibility allowance	24,000.00	6,000.00	_	_	_	Estimated
D	Annual bonus	6,000.00	4,000.00	2,000.00	1,600.00	1,200.00	Two months salary per year
E	Annual provident fund	3,600.00	2,400.00	1,200.00	960.00	720.00	10% (Basic salary)
F	Annual medical insurance	540.00	360.00	180.00	144.00	108.00	1.5% (Basic salary)
G	Annual leave	3,000.00	2,000.00	1,000.00	800.00	600.00	Monthly salary /Estimated/
H	Annual severance pay	1,500.00	1,000.00	500.00	400.00	300.00	Half month salary /Estimated/
ANNUAL FINANCE DEPARTMENT STAFF COSTS		**74,640.00**	**79,520.00**	**101,280.00**	**13,504.00**	**20,256.00**	**289,200.00**

Table 9-2 (Continued) – Logistics Department staff Annual cost in Birr

NUMBER OF STAFFS, SALARY AND BENEFITS		DEPARTMENT HEAD	DIVISION HEADS	CLERKS	SECRETARY	DRIVERS	REMARKS
A	Number of staff	1	3	6	1	2	Estimated
B	Annual basic salary	36,000.00	24,000.00	12,000.00	9,600.00	7,200.00	12 * Monthly basic salary
C	Annual responsibility allowance	24,000.00	6,000.00	_	_	_	Estimated
D	Annual bonus	6,000.00	4,000.00	2,000.00	1,600.00	1,200.00	Two months salary per year
E	Annual provident fund	3,600.00	2,400.00	1,200.00	960.00	720.00	10% (Basic salary)
F	Annual medical insurance	540.00	360.00	180.00	144.00	108.00	1.5% (Basic salary)
G	Annual leave	3,000.00	2,000.00	1,000.00	800.00	600.00	Monthly salary /Estimated/
H	Annual severance pay	1,500.00	1,000.00	500.00	400.00	300.00	Half month salary /Estimated/
ANNUAL LOGISTICS DEPARTMENT STAFF COSTS		**74,640.00**	**119,280.00**	**101,280.00**	**13,504.00**	**20,256.00**	**328,960.00**

Based on the estimated number of staffs, salary and benefits of the GC1 contractor in the example, the total annual head office staff costs are summarized in Table 9-3.

Table 9-3 – Summarized annual head office staff costs

DEPARTMENTS		AMOUNT IN BIRR
A	General Manager & Auditor's Office	313,200.00
B	Construction Department	479,360.00
C	Technical Department	479,360.00
D	Human Resource Department	369,472.00
E	Finance Department	289,200.00
F	Logistics Department	328,960.00
ANNUAL HEAD OFFICE STAFF COSTS		**2,259,552.00**

B – Small vehicle annual transportation expenses:

In estimating the annual head office small vehicle transportation expenses, the contractor shall identify the following points:

- ✓ The number of vehicles required at the head office
- ✓ Rental rate of vehicles
- ✓ Annual fuel consumption

As an illustration, let's take the same GC1 contractor and calculate the annual small vehicle transportation expenses based on the following assumptions:

A. Number of station wagon……..…6
B. Number of pick up……..…5
C. Average monthly rental rate for station wagon……10,000.00 Birr
D. Average monthly rental rate for pick up……7,500.00 Birr
E. Fuel expense per car……...…1,000.00 Birr/month

➥ ***Annual small vehicle transportation expense = 12*(A*C + B*D + 11*E)***

➥ ***Annual small vehicle transportation expense = 1,302,000.00 Birr***

C – Travel expenses:

The contractor shall also clearly identify all visiting travels from the head office to the projects as well as to other places such as meetings, trainings and so on. Therefore, contractors are advised to set their own per diem and travel expense scales based on the local and international market. Moreover, these per diem and travel expense scales shall be either equal or better than the Ethiopian civil servant per diem and travel expense scales, which helps to attract different hard to find professionals. As a matter of fact, the current Ethiopian civil servant per diem scales effective October 10, 2000 are given in Table 9-4.

Table 9-4 – Ethiopian Civil Servant Per Diem scales

BASIC MONTHLY SALARY IN BIRR		PER DIEM IN BIRR
A	Up to 300.00	35.00
B	301.00 ---- 600.00	47.00
C	601.00 ---- 900.00	58.00
D	901.00 and above	70.00
Source - Sur Construction plc, Human Resource Department		

In the case of the GC1 contractor, let's consider the following senior management project visit assumptions and calculate the annual head office travel expenses of the contractor.

A. Number of project visits per year……..4 (every quarter)
B. Number of visitors……..6 (senior management)
C. Per diem per person……140.00 Birr
D. Duration of travel…….……..7 days
E. Round trip transportation cost per person……..1000.00 Birr
F. Estimated annual trainings and other travels……..100,000.00 Birr

- ***Annual Head office travel expenses = A*B*C*D + A*B*E + F***
- ***Annual Head office travel expenses = 147,520.00 Birr***

D – Office building costs:

The annual cost of office buildings can be calculated based on the annual depreciation, if owned or the annual rental rate, if rented. According to the income tax proclamation No. 286/2002, the acquisition or construction cost and the cost of improvement, renewal and reconstruction of buildings shall be depreciated on a straight-line basis at five percent (5%) rate annually.

Let's assume the GC1 contractor owns an office building worth of six million birr including warehouses and workshops and calculate the annual building costs.

⇨ ***Annual building costs = 0.05 * 6,000,000.00***

⇨ ***Annual building costs = 300,000.00 Birr***

E – Bidding expenses:

The head office is also responsible to search for new bids and expends money mainly for bid document purchases, site visit expenses, bid bonds and so on. In calculating the annual bid expenses, the contractor shall identify:

- ✓ Estimated number of bids per year
- ✓ Estimated number site visits before submitting an offer
- ✓ Estimated bid document purchase amount
- ✓ Estimated bid bond expenses

Basically, there are two types of bid bonds requested by different project owners i.e. conditional or unconditional bid bonds. As a matter of fact, the local banks and insurance companies charge contractors with the following rates for providing bid bonds as shown in Table 9-5.

Table 9-5 – Local banks and insurance companies' bid bond financial charges

TYPE OF BOND		BANK		INSURANCE
		With collateral	Without collateral	
A	Unconditional bid bond	0.5% for 90days	0.75% for 90days	_
B	Conditional bid bond	_	_	1.5 up to 1.75% one time payment
Source - Sur Construction plc, Finance department				

As an example, let's assume the following bidding related assumptions for the GC1 contractor and calculate the annual bidding expenses.

- ✓ *Estimated number of bids per year……...10*
- ✓ *Estimated average bid amount per bid…..……200,000,000.00 Birr*
- ✓ *Estimated bid document purchase……1,000.00 Birr/bid*
- ✓ *Estimated duration of bid bond guarantee……..…..90 days*
- ✓ *Duration of site visit……..…..7 days per project*
- ✓ *Number of persons during site visit……2*
- ✓ *Per diem per person……..140.00 Birr*
- ✓ *Round trip transportation cost per person……..1000.00 Birr*

- ***Annual cost of bidding documents:***

  A. *Cost of bidding documents = 1000.00 birr/bid*
  B. *Annual cost of bidding documents =* ***10*A***

  ↳ ***Annual cost of bidding documents = 10,000.00 Birr***

- ***Annual cost of bid bonds:***

  A. *Estimated bid amount per bid = 200,000,000.00 Birr*
  B. *Estimated bid bond amount = 2,000,000.00 Birr (1% bid amount)*
  C. *Type of bid bond = Unconditional bank guarantee*
  D. *Annual cost of bid bonds =* ***0.0075*10*B***

  ↳ ***Annual cost of bid bonds = 150,000.00 Birr***

- ***Annual cost of site visits:***

  A. *Duration of site visit = 7days per bid*
  B. *Number of persons = 2 per visit*
  C. *Per diem = 140.00 Birr/day*
  D. *Round trip transportation = 1,000.00 Birr/person*
  E. *Annual cost of site visits = 10* (A*B*C + B*D)*

  ↳ ***Annual cost of site visits = 39,600.00 Birr***

After calculating all the annual cost of bidding documents, annual cost of bid bonds and annual costs of site visits, the annual cost of bidding is calculated as the sum of all these costs.

⇨ ***Annual bidding expenses = 10,000.00 + 150,000.00 + 39,600.00***

↳ ***Annual bidding expenses = 199,600.00 Birr***

F – Office furniture and equipments:

Contractors need to estimate the annual expenses related with the head office furniture and equipments. According to the income tax proclamation No. 286/2002, office furniture and equipments depreciate at the rate of 20% annually on a pooling system. Basically, contractors shall consider the following items in calculating the annual depreciation costs of office furniture and equipments.

- ✓ Tables and chairs
- ✓ File cabinets
- ✓ Computers and printers
- ✓ Photocopiers
- ✓ Repair costs of furniture and equipments

Consider the GC1 contractor has purchased office furniture and equipments worth 300,000.00 birr and calculate the annual office furniture and equipments expenses.

⇨ ***Annual office furniture and equipments expenses = 0.2 * 300,000.00 Birr***

⇨ ***Annual office furniture and equipments expenses = 60,000.00 Birr***

G – Office running expenses:

The head office operation requires lots of miscellaneous expenses to run the day-to-day activities of the head office. The following services shall be given due consideration in estimating the annual office running expenses.

- ✓ Telephones
- ✓ Fax
- ✓ Internet services
- ✓ Stationery
- ✓ Mail services
- ✓ Office cleaning items

Let's assume the GC1 contractor has the following office running expenses and calculate the annual office running expenses.

A. Telephone……...2000.00 Birr/department-month
B. Fax……...1000.00 Birr/month
C. Internet services……1000.00 Birr/month
D. Stationery……....500.00 Birr/department-month
E. Cleaning items……...500.00 Birr/month
F. Mail services……...96.00 Birr/year

⇨ ***Annual office running expenses = 12*(7*A + B + C + 7*D + E) + F***

⇨ ***Annual office running expenses = 240,096.00 Birr***

H – Sundry expenses:

As a construction firm, there are so many additional expenses whereby contractors expend such as for advertisement, reception parties and donations. Assume the GC1 contractor has the following budget for sundry expenses and calculate the annual sundry expenses.

- ✓ *Advertisement expenses……50,000.00 Birr/year*
- ✓ *Reception parties……..100,000.00 Birr/year*
- ✓ *Social donations……100,000.00 Birr/year*

⇨ ***Annual sundry expenses = 250,000.00 Birr***

At company level, the annual head office overhead costs can be summarized by adding all the above expenses as shown in Table 9-6.

Table 9-6 – Summarized Annual Head office overhead costs

ANNUAL HEAD OFFICE EXPENSES		AMOUNT IN BIRR
A	Head office staff costs	2,259,552.00
B	Small vehicle transportation expenses	1,302,000.00
C	Travel expenses	147,520.00
D	Building costs	300,000.00
E	Bidding expenses	199,600.00
F	Office furniture and equipment expenses	60,000.00
G	Office running expenses	240,096.00
H	Sundry expenses	250,000.00
ANNUAL HEAD OFFICE OVERHEAD COSTS		**4,758,768.00**

9-2 – SITE OVERHEAD COST ESTIMATION

Site overhead costs are all costs required to run the whole operation of a specific construction project at site level. These costs are not associated with specific activity in a project but rather shared proportionally by all activities within the project.

As discussed in chapter 5, in estimating the construction unit costs of an activity, site overhead costs are expressed as a percentage of the direct unit cost of each activity. Therefore, it is better to calculate the total site overhead costs of the project and shared these costs by the total direct cost of the project.

As an illustration, let's assume the following site overhead cost components and establish the site overhead costs of a specific project for a local GC1 contractor.

- ✓ Project site staff costs
- ✓ Project transportation facilities
- ✓ Project camps
- ✓ Mobilization and demobilization costs
- ✓ Detour and access roads
- ✓ Tender expenses

- ✓ Power and water supply costs
- ✓ Office furniture and equipment expenses
- ✓ Sundry expenses

A – Project site staff costs:

The project site staff costs mainly depends on the organizational structure of the project which reflects the number of staffs required and the salary and benefits scale of the project which in turn reflects the cost associated with each project staff. Moreover, the project staff manpower schedule is also important which reflects the duration of time a project staff stays in the project.

Therefore, in estimating the project staff costs, contractors shall clearly estimate the following salary and benefit scales of every project staff during his/her stay in the project.

- ✓ Basic salary
- ✓ Responsibility allowance
- ✓ Project allowance
- ✓ Hardship allowance
- ✓ Food allowance
- ✓ Bonus
- ✓ Overtime pay
- ✓ Medical insurance
- ✓ Annual leave
- ✓ Severance pay
- ✓ Provident fund

As an illustration, let's see an actual project site staff costs obtained from a local GC1 contractor working on an asphalt road project of 56kms with an estimated time for project completion of 2 years i.e. from March15, 2006 up to March 14 2008. The project organizational chart and the summarized project staff costs during construction and defects liability period are shown in chart 9-7 and Table 9-8 respectively.

CHART 9-7 – PROJECT ORGANIZATIONAL CHART

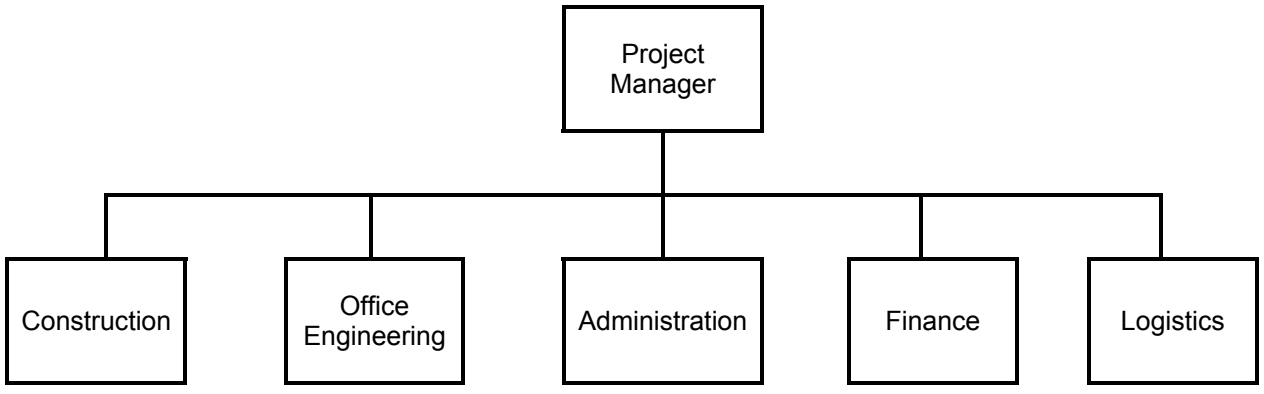

Table 9-8 – Summarized project site staff costs

PROJECT WORKING SECTIONS		AMOUNT IN BIRR
A	Project manager's office	319,620.00
B	Construction section	1,142,630.00
C	Office Engineering	1,393,770.00
D	Project Administration	441,000.00
E	Finance Section	216,600.00
F	Logistics section	1,114,270.00
TOTAL PROJECT SITE STAFF COSTS		**4,627,890.00**

B – Transportation facilities:

The project site staff requires small vehicles to run the day-to-day construction operation of the project. The contractor shall give due attention to the following items in estimating the project transportation expenses:

- ✓ Type and number of small vehicles
- ✓ Monthly rental rate of small vehicles
- ✓ Duration of service in the project

As an example, the actual project transportation expenses data obtained from the local GC1 contractor referred above are summarized in Table 9-9.

Table 9-9 – Summarized project small vehicle transportation expenses in Birr:

WORKING SECTION		NO OF SMALL VEHICLES	DURATION IN MONTHS	MONTHLY RENTAL RATE	TOTAL EXPENSE	REMARK
A	Project manager	1	30	10,000.00	300,000.00	Station wagon
B	Construction	3	24	7,500.00	540,000.00	Double cabin pick up
C	Office Engineering	1	24	7,500.00	180,000.00	Double cabin pick up
D	General service	1	24	7,500.00	180,000.00	Double cabin pick up
PROJECT TRANSPORTATION EXPENSES					**1,200,000.00**	

C – Project camps:

If the project is located out side cities and towns, the contractor has to construct different camp facilities to run the project construction operation properly. The size of project camps entirely depends on the manpower schedule whereby the peak manpower requirement of the project governs the size of these camps. These camps include but not limited to:

- ✓ Project staff residences
- ✓ Skilled and unskilled labor residence
- ✓ Project offices
- ✓ Warehouses and workshops
- ✓ Garages
- ✓ General services such as cafeteria, clinic, guard houses and so on
- ✓ Production yards such as concrete precast elements, concrete blocks, bar bending, steel structure manufacturing and so on

The other important point that contractors should consider is the type of construction materials to be used in the construction of the contractor's camps. There are practically many alternatives whereby a contractor can construct his project camps such as:

- ✓ Hollow concrete blocks
- ✓ Prefabricated materials
- ✓ Corrugated iron sheets
- ✓ Modified steel containers
- ✓ Moveable houses
- ✓ And many others

In road construction projects, contractors need to decide the number of project camps required. Experiences indicate that one project camp can cover from 40 to 60kms which is 20 to 30 km on both sides of the project camp.

The actual data obtained from the GC1 contractor indicates that there is only one project camp nearly at the mid way of the project and his camps are constructed basically from corrugated iron sheets but the offices and living camps are laminated with plywood and cement screed floor finish. The contractor's actual project camp costs are summarized in Table 9-10.

Table 9-10 – Summarized project camp expenses in Birr:

TYPE OF CAMP		UNIT	QUANTITY	UNIT RATE	TOTAL EXPENSE	REMARK
A	Residence & Offices	M2	2,000.00	500.00	1,000,000.00	With plywood
B	Warehouses	M2	500.00	400.00	200,000.00	Without plywood
C	General services	M2	600.00	500.00	300,000.00	With plywood
D	Production yards	M2	600.00	400.00	240,000.00	Without plywood
E	Garages	M2	400.00	400.00	160,000.00	Without plywood
F	Fencing	M	4,000.00	20	80,000.00	
PROJECT CAMP EXPENSES					**1,980,000.00**	

D – Mobilization and demobilization costs:

Contractors shall mobilize mainly construction machineries and labor force at different stages of the construction phase of the project. Moreover, these resources will be demobilized after completing the project construction works.

The mobilization and demobilization costs are mainly transportation costs. Therefore, contractors shall give due attention to the mobilization and demobilization of machineries and plants, camp furniture and equipments, small tools and equipments, erection and dismantling costs of crushing plants, batching plants and others. In this case, the contractor shall estimate:

- ✓ Number of machineries and plants required
- ✓ Volume of camp furniture and equipments
- ✓ Volume of small tools and equipments
- ✓ Number of trips using low beds
- ✓ Number of trips using courier trucks
- ✓ Number of self mobilizing and demobilizing equipments
- ✓ Rental rate of low beds and courier trucks
- ✓ Distance of the construction project from where the required resources will be mobilized and demobilized

As an example, the actual mobilization and demobilization costs of the local GC1 contractor considered in the above examples are summarized in Table 9-11.

Table 9-11 – Summarized mobilization and demobilization costs in Birr:

MOBILIZATION AND DEMOBILIZATION ACTIVITIES		TOTAL COSTS	REMARK
A	Earth moving Equipments	1,645,000.00	With low beds and courier trucks
B	Self moving Equipments	448,000.00	
C	Camp furniture and equipments	50,000.00	With courier trucks
D	Small tools and Equipments	40,000.00	With courier trucks
E	Crusher plants	300,000.00	Including foundation works
F	Asphalt batching plant	450,000.00	Including foundation works
MOBILIZATION AND DEMOBILIZATION COSTS		**2,933,000.00**	

E – Detour and Access roads:

Contractors shall thoroughly check the bidding documents whether detour roads are payable or not, especially for road construction projects. If detour roads are not included in the payable items, contractors shall calculate the cost of construction and maintenance of detour roads under the site overhead costs.

On the other hands there are also different access roads required to access different facilities of the project such as water supply, power supply, crushing plants, batching plants, borrow materials, local construction materials, construction camps and so on.

In the referred example, detour roads are payable items under the contract and there is no need for the GC1 contractor to calculate the detour road costs under the site overhead costs.

However, the contractor has estimated 5kms of access roads will constructed to access different project facilities. Moreover, based on the site conditions and previous experiences, the contractor estimated the cost of access road construction and maintenance is about 100,000.00 Birr/km.

- *Detour and access road costs = 5*100,000.00*
- ***Detour and access road costs = 500,000.00 Birr***

F – Tender Expenses:

The tender expenses of a project are mainly financial charges related with performance bond, advance repayment guarantee bond, insurance of the works and third party insurance. Therefore, in estimating the tender expenses of a project, contractors shall properly study the contract documents in relation to:

- ✓ Type of bonds i.e. conditional or unconditional
- ✓ Amount of bonds required
- ✓ Who covers insurance of the works
- ✓ Amount of third party insurance

As a reference, the local banks and insurance companies charge contractors the following rates for performance bonds, advance repayment guarantee bonds, insurance of the works and third party insurance as shown in Table 9-12.

Table 9-12 – Local banks and insurance companies' financial charges

TYPES OF BONDS		BANK		INSURANCE
		With collateral	Without collateral	
A	Performance bond	0.5% for 90days	0.75% for 90days	1.5 up to 1.75% one time payment
B	Advance repayment guarantee bond	0.5% for 90days	0.75% for 90days	1.75 up to 2% one time payment
C	Insurance of the works	–	–	0.75 up to 1% one time payment
D	Third party insurance	–	–	1 up to 1.5% one time payment
Source – Sur Construction plc, Finance department				

Tender expenses are calculated based the total tender amount. Therefore, as an example, let's assume the following assumptions and calculate the tender expenses of a project.

- ✓ *Total tender amount……150,000,000.00 Birr*
- ✓ *Time for completion……...2 years*
- ✓ *Unconditional performance bond……10%*
- ✓ *Amount of advance payment……20%*
- ✓ *Type of advance repayment bond……Unconditional*
- ✓ *Insurance of the works……Contractor*
- ✓ *Third party insurance……...10%*

- ***Performance bond costs:***

  A. *Duration of performance bond = 3 years (Including defects liability period)*
  B. *Number of payment periods = 12*
  C. *Performance bond costs = 0.1*150,000,000.00*12*0.0075*

  ↳ ***Performance bond costs = 1,350,000.00 Birr***

- ***Advance repayment guarantee bond costs:***

  A. *Duration of advance repayment bond = 2 years*
  B. *Number of payment periods = 8*
  C. *Advance repayment guarantee bond costs = 0.2*150,000,000.00*8*0.0075*

  ↳ ***Advance repayment guarantee bond costs = 1,800,000.00 Birr***

- ***Insurance of the works:***

  A. *Insurance costs = 0.0075*150,000,000.00*
     ↳ ***Insurance costs = 1,125,000.00 Birr***

- ***Third party insurance:***

  A. *Amount of third party insurance = 15,000,000.00 Birr*
  B. *Insurance costs = 0.01*15,000,000.00*

  ↳ ***Insurance costs = 150,000.00 Birr***

Therefore, the total tender costs of the project are the sum of all costs related to performance bonds, advance repayment guarantee bonds, insurance of the works and third party insurance.

↳ ***Tender expenses = 1,350,000 + 1,800,000 + 1,125,000 + 150,000***

↳ ***Tender expenses = 4,425,000.00 Birr***

G – Power and water supply:

Power and water supplies are very crucial to the contractor to run the day-to-day activities of the project. Contractors shall give due attention to the following items in estimating the power and water supply costs of the project:

- ✓ Source of water supply
- ✓ Type and size of water trucks and stationery water tankers
- ✓ Type, size and numbers of water pumps

- ✓ Size and length of water supply pipes
- ✓ Construction and running costs of water supply
- ✓ Source of power supply
- ✓ Type, size and numbers of generators
- ✓ Quantity of cables, control panels and other accessories
- ✓ Construction and running costs of power supply

As an illustration, let's see the actual power and water supply expenses of the local GC1 contractor as summarized in Table 9-13.

Table 9-13 – Summarized power and water supply costs in Birr:

TYPE OF FACILITY		TOTAL COSTS	REMARK
A	Electric generators	415,000.00	
B	Submersible pumps	40,000.00	
C	Stationery water tankers	50,000.00	
D	Mobile water truck	210,000.00	
E	Well drilling and investigation	175,000.00	
F	Centrifugal water pump	25,000.00	
POWER AND WATER SUPPLY COSTS		**915,000.00**	

H – Office furniture and equipments and other miscellaneous costs:

Similar as that of the head office, project site office requires different office furniture and equipments to run the day-to-day activities of the project site staffs. Moreover, the project site offices also require additional office running costs. Therefore, contractors shall give due attention to the following items in calculating the project office furniture and equipments.

- ✓ Tables and chairs
- ✓ File cabinets
- ✓ Computers and printers
- ✓ Photocopiers
- ✓ Repair costs of furniture and equipments
- ✓ Surveying equipments
- ✓ Telephones
- ✓ Fax
- ✓ Mobile and stationed radios
- ✓ Internet services
- ✓ Stationery
- ✓ Mail services
- ✓ Office cleaning items

The actual data obtained from the local GC1 contractor shows his budget for project site office furniture and equipments as well as other miscellaneous expenses are given below.

- ***Project site office costs = 400,000.00 Birr***

I – Sundry expenses:

On the project site, it is very normal that the contractor will participate in some form of social activities with the local community. Moreover, sometimes it is very important to prepare occasional entertainment programs both to his employees as well as the supervision staff. Therefore, contractors are advised to estimate these costs properly and add to the project costs under the site overhead costs. As an example, the following costs are assumed as the project sundry expenses.

- ✓ *Reception parties……..100,000.00 Birr*
- ✓ *Social donations……100,000.00 Birr*

- ***Project sundry expenses = 200,000.00 Birr***

After calculating all site overhead related costs, the total site overhead cost of a specific project can be summarized by adding all the above site overhead costs as shown in Table 9-14.

Table 9-14 – Summarized Site overhead costs

PROJECT SITE OVERHEAD COSTS		AMOUNT IN BIRR
A	Project site staff costs	4,627,890.00
B	Transportation costs	1,200,000.00
C	Project camp costs	1,980,000.00
D	Mobilization and demobilization costs	2,933,000.00
E	Detour and access roads	500,000.00
F	Tender expenses	4,425,000.00
G	Power and water supply costs	915,000.00
H	Office furniture and equipments	400,000.00
I	Project sundry expenses	200,000.00
PROJECT SITE OVERHEAD COSTS		**17,180,890.00**

In order to demonstrate on how to express the head office overhead costs and the site overhead costs as a percentage of the direct unit cost of an activity, let's assume the local GC1 contractor has the same annual head office overhead costs as calculated under section 9-1 and site overhead costs of the road project as calculated under section 9-2.

Moreover, assume the contractor is currently running four projects and wants to bid for the above mentioned road project with the estimated annual direct cost turnover of each project as shown in Table 9-15. Accordingly, calculate the head office overhead costs and site overhead costs as a percentage of the direct unit cost the project activities in the new project whereby the contractor is bidding.

Table 9-15 – Annual direct cost turnover by projects

PROJECTS		DIRECT COST ANNUAL TURNOVER			TOTAL DIRECT COST
		2006	2007	2008	
1	Project 1	20,453,250.00	28,254,830.00	15,324,324.00	64,032,404.00
2	Project 2	25,748,792.00	32,564,789.00	30,345,896.00	88,659,477.00
3	Project 3	62,606,456.00	73,567,897.00	47,786,234.00	183,960,587.00
4	Project 4	71,567,934.00	82,896,564.00	63,675,895.00	218,140,393.00
5	New project under bid	33,235,562.00	52,500,000.00	23,195,652.00	108,931,214.00
ANNUAL DIRECT COST TURNOVER		**213,611,994.00**	**269,784,080.00**	**180,328,001.00**	**663,724,075.00**

- ***Head office overhead costs:***

  A. *Average annual direct cost turnover = 221,241,358.33 Birr*
  B. *Annual head office overhead costs = 4,758,768.00 Birr*

  - ***Head office overhead costs = (B/A)*100***
  - ***Head office overhead costs = 2.15%***

- ***Site overhead costs:***

  A. *Total new project direct cost = 108,931,214.00 Birr*
  B. *Project site overhead costs = 17,180,890.00 Birr*

  - ***Site overhead costs = (B/A)*100***
  - ***Site overhead costs = 15.77 %***

10 – RISK ALLOWANCE ESTIMATION

As discussed in chapter 3, contractors may incorporate risk allowances in their tender prices to compensate the negative impacts of different risks such as political, contractual, technical and economic risks.

All these political, contractual, technical and economic risks have the tendency of increasing the price of construction materials, labor and equipments. This general increase in prices is called inflation. There is also a special term for very rapid and constantly growing rate of inflation called hyperinflation.

There are also rare cases whereby these risks have a positive economic impact in which the price of construction materials, labor and equipments may decrease and this general decrease in prices is called deflation.

Contractors are particularly interested in inflation in order to estimate the future price increment of construction materials, labor and equipments. Therefore, contractors need to study the local and international market trends carefully in estimating the risk allowance to be included in their cost estimation for construction projects.

In studying the local and international construction market trends, local and international consumer price indices published on monthly basis as well as current market prices are very important indicatives during decision making in regard of the amount of risk allowance to be incorporated in the cost estimation of construction projects.

In Ethiopia, the Central Statistics Agency (CSA) is publishing the construction materials consumer price index on monthly basis starting from December 2000 for Ethiopia at country level and for each regional state. As a matter of fact, the construction materials consumer price of index at country level and in Addis are provided in Table 10-1, which is extracted from the Central Statistics Agency consumer price index publication for the month of February 2006**.**

However, even though a good start, the construction materials consumer price index published by the Central Statistics Agency has so many major shortcomings whereby contractors are not advised to take these data as a sole basis for the risk allowance estimation in their tender prices due to the following basic shortcomings:

- *Construction materials are categorized under the same group with house rent, fuel and power.*
- *All types of construction materials are grouped under one category whereas the rate of price increment for construction materials widely vary depending on the type of materials.*

- *Locally produced construction materials and imported construction materials are treated under the same group of consumer price index.*
- *Governmentally controlled material prices are grouped with market oriented material prices such as fuel as compared to cement.*
- *Moreover, the published consumer price index does not include construction labor and construction equipments.*

Table 10-1 – Construction materials consumer price index for Ethiopia and Addis Ababa

YEAR		CONSUMER PRICE INDEX		REMARK
		ETHIOPIA	ADDIS ABABA	
1	DECEMBER 2000	100.00	100.00	Base Index
2	July 2001 – June 2002	103.80	96.70	
3	July 2002 – June 2003	106.10	100.20	
4	July 2003 – June 2004	112.80	107.50	
5	July 2004 – June 2005	123.20	119.20	
6	FEBRUARY 2006	138.90	127.20	
Source – Ethiopian Central Statistics Agency, CPI for the month of February 2006				

Even though very crude, let's demonstrate to establish the annual construction materials price increment in Ethiopia at country level as summarized in Table 10-2 based on the construction materials price index given in Table 10-1.

Table 10-2 – Construction materials annual price increment for Ethiopia

YEAR		ANNUAL PRICE INCREMENT		REMARK
		CPI	%	
1	DECEMBER 2000	100.00	0.00	**As compared to the previous year**
2	July 2001 – June 2002	103.80	3.80	
3	July 2002 – June 2003	106.10	2.22	
4	July 2003 – June 2004	112.80	6.31	
5	July 2004 – June 2005	123.20	9.22	
6	FEBRUARY 2006	138.90	12.74	

As it can be seen from Table 10.2, the price of construction materials has increased by 12.74% in year 2006 as compared with the price of construction materials in year 2005 which is actually the highest increment as compared to all the previous years.

As demonstrated in Table 10-2, the construction materials consumer price index published by the Ethiopian Central Statistics Agency can only give a clue on the price increment of construction materials but not for construction labor and equipments. Therefore, local contractors are strongly advised to have their own market records of construction materials, labor and equipments and develop their own respective price indices.

Moreover, contractors have to check thoroughly the contract documents if there is any provision of price escalation for material, labor and equipments before deciding the amount of risk allowance to be added to the estimated unit prices.

As an illustration, let's consider the road project referred in section 9-2 has a price escalation provision as follows:

$$\mathbf{P_n = a + b}\frac{Mn}{Mo}\mathbf{ + c}\frac{Ln}{Lo}\mathbf{ + d}\frac{En}{Eo}$$

Where,

- 'P_n' represents the adjustment multiplier for value works executed in period 'n'
- 'a' represents non-adjustable portion of the estimated contract value
- 'b' represents the material cost component of the estimated contract value
- 'c' represents the labor cost component of the estimated contract value
- 'd' represents the equipment cost component of the estimated contract value
- Mo, Lo and Eo represents the base price index for material, labor and equipment
- Mn, Ln and En represents the current price index on a specified time before period 'n' for material, labor and equipment
- **a + b + c + d = 1**

In this case, it is only for the non-adjustable portion ('**a**'**)** of the estimated contract value that the contractor may consider to include risk allowance in his tender unit prices.

On the other hand, there are many local contracts with price escalation provisions for certain specified construction materials such as cement, reinforcement steel, fuel, wooden plunks and so on whereby the contractor submits his base prices for the specified construction materials in his tender. In this case, the contractor shall calculate the total value of the adjustable materials and deduct from the total estimated contract value to get the non-adjustable portion of the contract whereby the contractor may include risk allowance to his tender prices.

Let's demonstrate to establish the risk allowance amount which may be considered to be included in the unit costs of the project referred in section 9-2 with the following assumptions:

- ✓ *Non adjustable portion of the contract value……..……60%*
- ✓ *Estimated annual increment of material price……..…...10%*
- ✓ *Estimated annual increment of equipment cost……..……..7%*
- ✓ *Estimated annual increment of labor cost…….……...5%*
- ✓ *Estimated annual increment of site overhead cost……....3%*
- ✓ *Estimated annual increment of head office overhead cost……....2%*

Therefore, based on the above assumptions of annual cost increment for construction materials, labor, equipment, site overhead costs and head office overhead costs, the estimated future price index of each cost components are summarized in Table 10-3.

Table 10-3 – Estimated price index

COST COMPONENTS		ESTIMATED PRICE INDEX		
		2006	2007	2008
A	Estimated Material price index	100	110	121
B	Estimated labor cost index	100	107	114.49
C	Estimated equipment cost index	100	105	110.25
D	Estimated site overhead cost index	100	103	106.09
E	Estimated head office overhead cost index	100	102	104.04

The next step is to calculate the annual direct cost turnover of the specific project under bid as summarized in Table 10-4 based on the assumptions made in Table 9-15.

Table 10-4 – Annual direct cost turnover in Birr

NEW PROJECT UNDER BID		ANNUAL DIRECT COST TURNOVER			TOTAL
		2006	2007	2008	
A	Projected direct cost turnover in Birr	33,235,562.00	52,500,000.00	23,195,652.00	108,931,214.00
B	Projected direct cost turnover in %	31	48	21	100

Therefore, based on the estimated price index in Table 10-3, the estimated projected direct cost turnover in Table 10-4 and the non-adjustable portion of the estimated contract value of the new project under bid, which is assumed to be 60%, the risk allowance increment expressed as a percentage of each cost component are calculated and summarized in Table 10-5.

Table 10-5 – Risk allowance of each cost component in %

COST COMPONENTS		CALCULATION and CLARIFICATION	COST INCREMENT
A	Direct material cost increment	0.6 * (0.1*0.48+0.21*0.21)	5.53%
B	Direct labor cost increment	0.6 * (0.07*0.48+0.1449*0.21)	3.84%
C	Direct equipment cost increment	0.6 * (0.05*0.48+0.1025*0.21)	2.73%
D	Site overhead cost increment	0.6 * (0.03*0.48+0.0609*0.21)	1.63%
E	Head office overhead cost increment	0.6 * (0.02*0.48+0.0404*0.21)	1.09%

↳ **Risk Allowance = 0.0553*E + 0.0384*F + 0.0273*G + 0.0163*I+ 0.0109*J**

Where,

- → **E**----------Direct material cost
- → **F**----------Direct labor cost
- → **G**----------Direct equipment cost
- → **I**----------Site overhead cost
- → **J**----------Head office overhead cost

11 – WORKED OUT EXAMPLES

In order to demonstrate the proposed construction cost estimation formats and to have a better understanding of construction cost estimation in general, the establishment of cost estimates for some construction activities will be exercised under this chapter.

Moreover, all the assumptions and the results of the worked out examples in all the above chapters, which are summarized in Table 11-1, will be used in establishing the cost estimates of these construction activities, which will be demonstrated under this chapter.

Table 11-1 – Assumed cost factors

COST COMPONENTS		ASSUMED FACTOR	REMARK
A	Labor Index	1.3	
B	Head Office Overhead Costs	2.15%	
C	Site Overhead Costs	15.77%	
D	Risk Allowance for Direct Material	5.53%	
E	Risk Allowance for Direct Labor	3.84%	
F	Risk Allowance for Direct Equipment	2.73%	
G	Risk Allowance for Site Overhead Costs	1.63%	
H	Risk Allowance for Head Office Overhead Costs	1.09%	
I	Net profit	10% (Break even cost)	

Based on the assumptions made in Table 11-1 and construction data obtained from EBCA and ERA performance standards as well as the current material costs, labor costs and equipment rental rates during the month of April 2006 in Addis, the unit prices of the following sample construction activities are established as demonstrated below for a VAT registered contractor bidding on a road project located in Addis Ababa.

A – Sample 1: Concrete class C-25

Provision and placing of concrete for isolated footings class C-25 with minimum cement content of 360kg/m^3 filled into formwork and vibrated properly around reinforcement whereby formwork and reinforcement will be measured separately.

In this case, the contractor should note the following points before deciding the unit price for concrete works class C-25 to be used in isolated footings:

- ✓ *The contractor is free to choose the cement type as far as the strength and minimum cement content are maintained. Currently Muger PPC, Messobo PPC and Messobo OPC cements are available in the market.*
- ✓ *Identify possible sources and suppliers for suitable coarse and fine aggregates.*
- ✓ *Depending on the volume of concrete works, construction schedule, quality of works and cost effectiveness, the contractor shall choose appropriate construction method for concrete works such as:*
  - ⇨ *Mechanical mixer + Labor*
  - ⇨ *Mechanical mixer + dumper + Labor*
  - ⇨ *Mechanical mixer + mobile crane + Labor*
  - ⇨ *Truck mixer + Labor*
  - ⇨ *Truck mixer + mobile crane + Labor*
  - ⇨ *Concrete batching plant + Truck mixer + Labor*
  - ⇨ *Concrete batching plant + Truck mixer + Concrete pump + Labor*

B – Sample 2: Formwork

Supply, erect and remove after use formwork for isolated footings sufficient to contain the wet concrete without leakage and enough to support temporary loading and pressure from placing and compaction.

In estimating the unit price for isolated footing formwork, the contractor should note the following points:

- ✓ *Identify the type of formwork material to be used such as wooden plunks and steel panels or a combination of the two.*
- ✓ *Number of usages of formwork materials.*
- ✓ *Based on the construction method to be adopted identify the quantity of required materials, labor and equipment and estimated crew productivity.*

C – Sample 3: Natural sub base production

The work comprises excavation, screening and stockpiling of natural sub base material, which will be used for sub base construction of road works.

In dealing with earthworks, it has to be noted that payment will be made based on the compacted volume of work executed. Therefore, it is very important to identify the shrinkage and load factors of the sub base material to calculate the compacted volume of sub base material produced. Moreover, the contractor shall also identify all required resources in a working crew such as:

- ✓ *The type, capacity and number of dozers*
- ✓ *Required number of skilled and unskilled labor*

D – Sample 4: Sub base hauling

Sub base hauling comprises loading at the sub base stockpile area, hauling this material to the required road location and dumping.

In estimating the unit price for sub base hauling, the contractor shall obtain proper and reliable data on the following items:

- ✓ *Hauler nominal capacity*
- ✓ *Loader bucket capacity*
- ✓ *Hauler fill factor*
- ✓ *Loader fill factor*
- ✓ *Material load factor*
- ✓ *Material shrinkage factor*
- ✓ *Hauler cycle time*
- ✓ *Loader cycle time*

In this particular example, let's assume the following assumptions and calculate the loader-hauler balance and the estimated crew productivity.

- ✓ *Hauling distance……..5km*
- ✓ *Average speed of haulers……..25km/hr*
- ✓ *Hauler fill factor……...1*
- ✓ *Loader fill factor……....….1*
- ✓ *Loader cycle time……...1.25 minutes*
- ✓ *Hauler dump time……...2 minutes*
- ✓ *Hauler nominal capacity……..…..12m^3*
- ✓ *Loader bucket capacity……...…...3m^3*
- ✓ *Load factor…….…..……0.80*
- ✓ *Shrinkage factor……..……1.25*

❖ ***Number of haulers required per loader***

*A. Hauler travel time……..(2*5)/25 = 24 minutes*
*B. Hauler load time……(12/3)*1.25 = 5 minutes*
C. Hauler dump time……...2 minutes
D. Hauler cycle time……...24+5+2 = 31 minutes

- *Number of haulers = Hauler cycle time/Hauler load time*
- *Number of haulers = 31/5 = 6.2*
- ***Take 6 dump trucks***

❖ ***Estimated crew productivity (1 loader + 6 dump trucks)***

A. Hauler nominal capacity……12m^3
B. Hauler fill factor……1
C. Material load factor……..0.80
*D. Hauler useful capacity…….A*B*C (in bank volume)*

- *Hauler useful capacity = 12*1*0.80*
- *Hauler useful capacity = 9.6Bm^3*

E. Material shrinkage factor ……..1.25
F. Hauler useful capacity……...D/E (in compacted volume)

- *Hauler useful capacity = 9.6/1.25*
- *Hauler useful capacity = 7.68Cm^3*

*G. Crew productivity ……..6*F*(60/31)*

- *Crew productivity = 6*7.68*(60/31)*
- ***Crew productivity = 89.19 Cm$^{3/}$Hr***

E – Sample 5: Sub base placing

Sub base placing comprises spreading, mixing of sub base material with water, placing mixed material to a specified thickness and compaction as specified.

In a similar manner as that of the sub base production and hauling, sub base placing will also be measured in compacted volume for payment. Therefore, the contractor shall identify the estimated load and shrinkage factors of the sub base material placed to calculate the compacted volume of work executed. The other most important point to be considered in estimating the unit price of sub base placing is to identify equipments and manpower required in a crew such as:

- ✓ *Type, capacity and number of graders*
- ✓ *Average distance of water supply from the working area*
- ✓ *Type, number and capacity of water trucks*
- ✓ *Type, number and capacity of rollers*
- ✓ *Required number of skilled and unskilled labor*

PRICE ANALAYSIS SHEET FOR SAMPLE 1

PROJECT LOCATION	**ADDIS ABABA**
ACTIVITY CODE	**SAMPLE 1**
UNIT OF MEASURE	**M^3**

ACTIVITY DESCRIPTION	Concrete class C-25 for Isolated footing foundation.

DIRECT MATERIAL COST					**DIRECT LABOR HOURLY COST**						**DIRECT EQUIPMENT HOURLY COST**				
Material Description	Unit	Quantity	Unit cost	Total cost	Labor by trade	No of labor	Basic salary	Labor index	UF	Total cost	Equipment description	No of equipments	Hourly cost	UF	Total cost
Cement	Kg	378	0.84	317.52	Foreman	1	5	1.3	1	6.5	Concrete mixer 500ltr	1	25	1	25
Fine Aggregate	M3	0.55	140	77.00	Mixer operator	1	2.5	1.3	1	3.25	Concrete Vibrator	2	5	1	10
Coarse Aggregate	M3	0.83	150	124.50	Mason	2	3.75	1.3	1	9.75					
Water	M3	0.23	3.94	0.91	Unskilled labor	25	1.25	1.3	1	40.63					
A - TOTAL DIRECT MATERIAL COST				519.93	**B – TOTAL DIRECT LABOR HOURLY COST**					60.13	**C – TOTAL EQUIPMENT HOURLY COST**				35.00

D – Hourly crew productivity	**1.00**
E – Direct material cost	**519.93**
F – Direct labor cost	**60.13**
G – Direct equipment cost	**35.00**
H – DIRECT UNIT COST	**615.06**
I – Site overhead costs	**96.99**
J – Head office overhead costs	**13.22**
K – INDIRECT UNIT COST	**110.21**

L – RISK ALLOWANCE	**33.74**
M – GROSS PROFIT	**108.43**
N – TOTAL UNIT PRICE WITHOUT VAT	**867.44**
O – VALUE ADDED TAX (VAT)	**130.12**
P – TOTAL UNIT PRICE WITH VAT	**997.56**
REMARK	

PRICE ANALAYSIS SHEET FOR SAMPLE 2

PROJECT LOCATION	**ADDIS ABABA**
ACTIVITY CODE	**SAMPLE 2**
UNIT OF MEASURE	**M^2**

ACTIVITY DESCRIPTION	Formwork for isolated footing foundation.

DIRECT MATERIAL COST					**DIRECT LABOR HOURLY COST**						**DIRECT EQUIPMENT HOURLY COST**				
Material Description	Unit	Quantity	Unit cost	Total cost	Labor by trade	No of labor	Basic salary	Labor index	UF	Total cost	Equipment description	No of equipments	Hourly cost	UF	Total cost
25mm thick wooden plunk	M2	0.26	88.35	22.97	Foreman	1	5.00	1.3	0.1	0.65					
Battens	M	1	4	4.00	Carpenter	1	3.75	1.3	1	4.88					
Struts	M	1	4	4.00	Ass. Carpenter	1	2.50	1.3	1	3.25					
Nail	Kg	0.05	7.50	0.38	Unskilled labor	1	1.25	1.3	1	1.63					
Mould oil	Ltr	0.015	4	0.06											
A - TOTAL DIRECT MATERIAL COST				31.41	**B - TOTAL DIRECT LABOR HOURLY COST**					10.41	**C – TOTAL EQUIPMENT HOURLY COST**				

D – Hourly crew productivity	**0.50**
E – Direct material cost	**31.41**
F – Direct labor cost	**20.82**
G – Direct equipment cost	**0.00**
H – DIRECT UNIT COST	**52.23**
I – Site overhead costs	**8.24**
J – Head office overhead costs	**1.12**
K – INDIRECT UNIT COST	**9.36**

L – RISK ALLOWANCE	**2.68**
M – GROSS PROFIT	**9.18**
N – TOTAL UNIT PRICE WITHOUT VAT	**73.45**
O – VALUE ADDED TAX (VAT)	**11.02**
P – TOTAL UNIT PRICE WITH VAT	**84.47**
REMARK	

PRICE ANALAYSIS SHEET FOR SAMPLE 3

PROJECT LOCATION	**ADDIS ABABA**
ACTIVITY CODE	**SAMPLE 3**
UNIT OF MEASURE	**CM^3**

ACTIVITY DESCRIPTION	Natural sub base production.

DIRECT MATERIAL COST					**DIRECT LABOR HOURLY COST**						**DIRECT EQUIPMENT HOURLY COST**				
Material Description	Unit	Quantity	Unit cost	Total cost	Labor by trade	No of labor	Basic salary	Labor index	UF	Total cost	Equipment description	No of equipments	Hourly cost	UF	Total cost
					Quarry Foreman	1	5.00	1.3	1	6.50	Dozer D8N	1	767	1	767
					Unskilled labor	1	1.25	1.3	1	1.63					
A - TOTAL DIRECT MATERIAL COST					**B - TOTAL DIRECT LABOR HOURLY COST**					8.13	**C – TOTAL EQUIPMENT HOURLY COST**				767.00

D – Hourly crew productivity	**70**
E – Direct material cost	**0.00**
F – Direct labor cost	**0.12**
G – Direct equipment cost	**10.96**
H – DIRECT UNIT COST	**11.08**
I – Site overhead costs	**1.75**
J – Head office overhead costs	**0.24**
K – INDIRECT UNIT COST	**1.99**

L – RISK ALLOWANCE	**0.33**
M – GROSS PROFIT	**1.91**
N – TOTAL UNIT PRICE WITHOUT VAT	**15.31**
O – VALUE ADDED TAX (VAT)	**2.30**
P – TOTAL UNIT PRICE WITH VAT	**17.61**
REMARK	

PRICE ANALAYSIS SHEET FOR SAMPLE 4

PROJECT LOCATION	**ADDIS ABABA**
ACTIVITY CODE	**SAMPLE 4**
UNIT OF MEASURE	**CM^3**

ACTIVITY DESCRIPTION	Sub base hauling from 5km distance.

DIRECT MATERIAL COST					**DIRECT LABOR HOURLY COST**						**DIRECT EQUIPMENT HOURLY COST**				
Material Description	Unit	Quantity	Unit cost	Total cost	Labor by trade	No of labor	Basic salary	Labor index	UF	Total cost	Equipment description	No of equipments	Hourly cost	UF	Total cost
					Quarry Foreman	2	5.00	1.3	1	13.00	Loader $3m^3$	1	380	1	380
					Unskilled labor	2	1.25	1.3	1	6.50	Dump Truck 12 m^3	6	200	1	1200
A - TOTAL DIRECT MATERIAL COST					**B - TOTAL DIRECT LABOR HOURLY COST**					19.50	**C – TOTAL EQUIPMENT HOURLY COST**				1580

D – Hourly crew productivity	**89.19**
E – Direct material cost	**0.00**
F – Direct labor cost	**0.22**
G – Direct equipment cost	**17.71**
H – DIRECT UNIT COST	**17.93**
I – Site overhead costs	**2.83**
J – Head office overhead costs	**0.39**
K – INDIRECT UNIT COST	**3.22**

L – RISK ALLOWANCE	**0.54**
M – GROSS PROFIT	**3.10**
N – TOTAL UNIT PRICE WITHOUT VAT	**24.79**
O – VALUE ADDED TAX (VAT)	**3.72**
P – TOTAL UNIT PRICE WITH VAT	**28.51**
REMARK	

PRICE ANALAYSIS SHEET FOR SAMPLE 5

PROJECT LOCATION	**ADDIS ABABA**
ACTIVITY CODE	**SAMPLE 5**
UNIT OF MEASURE	**CM^3**

ACTIVITY DESCRIPTION	Sub base placing.

DIRECT MATERIAL COST					**DIRECT LABOR HOURLY COST**						**DIRECT EQUIPMENT HOURLY COST**				
Material Description	Unit	Quantity	Unit cost	Total cost	Labor by trade	No of labor	Basic salary	Labor index	UF	Total cost	Equipment description	No of equipments	Hourly cost	UF	Total cost
					Earthwork Foreman	1	5	1.3	1	6.50	Motor Grader 140G	2	430	1	860
					Unskilled labor	10	1.25	1.3	1	16.25	Front Vibratory Back Wheel Roller 10t	2	220	1	440
											Water Truck 1000ltr	2	200	1	400
A - TOTAL DIRECT MATERIAL COST					**B - TOTAL DIRECT LABOR HOURLY COST**					22.75	**C – TOTAL EQUIPMENT HOURLY COST**				1700

D – Hourly crew productivity	**87.50**
E – Direct material cost	**0.00**
F – Direct labor cost	**0.26**
G – Direct equipment cost	**19.43**
H – DIRECT UNIT COST	**19.69**
I – Site overhead costs	**3.11**
J – Head office overhead costs	**0.42**
K – INDIRECT UNIT COST	**3.53**

L – RISK ALLOWANCE	**0.60**
M – GROSS PROFIT	**3.40**
N – TOTAL UNIT PRICE WITHOUT VAT	**27.22**
O – VALUE ADDED TAX (VAT)	**4.08**
P – TOTAL UNIT PRICE WITH VAT	**31.30**
REMARK	

12 – CONCLUSIONS AND RECOMMENDATIONS

The sole basis whereby construction companies obtain different construction projects is mainly based on tight financial competition with different local and international contractors. It is very clear that the basis of price competition in the construction industry lays entirely on information related to the following crucial cost related items:

- ✓ Performance standards
- ✓ Direct labour cost
- ✓ Direct material cost
- ✓ Direct equipment cost
- ✓ Site overhead costs
- ✓ Head office overhead costs
- ✓ Risk allowance
- ✓ Profit margin

Lack of appropriate updated data and competence in estimating on any one of these cost related items may result either in higher project cost estimates whereby the company may loose profitable business opportunities or lower project cost estimates whereby the company may execute projects at loss causing huge financial damage to its cash flow affecting all other healthy projects.

Therefore, being in a competitive business environment, construction companies must have clear, updated and accurate cost database on the above stated cost related items. Moreover, this cost database shall be refined from time to time based the actual performance of the company as well as current external and internal prevailing business environments.

Healthy and sound company cost database not only helps to have competent project cost estimates but it is also the sole basis to evaluate the performance of project execution during construction. There is an old saying but fresh in its contextual meaning, **"WELL PLANNED IS HALF DONE"**.

Generally, in establishing and maintaining sound company cost database, there are basically five broaden stages whereby each stage shall be interlinked to each other for continual database updating and refinement.

- **STAGE 1** - The first stage in establishing company cost database is to establish the initial company cost database based on previous experiences, experiences of similar construction firms, national and international standards, research outcomes and so on.

- **STAGE 2** – Once the company initial cost database is established, the next stage is to develop mechanisms of data collection of each cost component based on the actual performance of the company.

- **STAGE 3** – Data collection by itself is not an end unless the collected data is processed to compare the actual performance versus the planned targets of the company. Therefore, at this stage, all collected data shall be properly checked and processed to compare the actual performance of the company as compared to its planned targets.

- **STAGE 4** – The fourth stage in establishing sound company cost database is the learning stage from the outcomes of the processed actual data in comparison with the initial target plans.

- **STAGE 5** – The last stage is actually establishing a refined company cost database based on the actual outcomes obtained at the learning stage from the actual performance of the company. Moreover, in addition to the opportunities and threats from the external environment, the refined company cost database shall serve as the sole basis to establish company's planned targets for the next operational phase.

The planning, learning and improvement processes in establishing refined company cost database shall be done through out the life of the company and company cost database have to be refined at least on yearly basis so that the company puts itself on a sound cost estimation and performance evaluation ground in the highly competitive construction business environment.

Basically, accurate and updated cost database is one of the fundamental bases for the continual and healthy growth of the local construction industry. Therefore, in addition to all earlier discussions, the author recommends the following points to the government, contractors, consultants, professional associations, higher institutions and other stakeholders.

1. The sole basis for competent construction cost estimation is refined cost database such as material price, labor cost, equipment hourly cost, subcontractor's price, crew productivity, resource utilization and so on. Therefore, contractors need to have continual performance data collection and data processing mechanisms.

2. The Ministry of Works and Urban Development, Central Statistics Agency, Contractors Association, Consultants Association, Civil engineers Association, Architects Association and other related professional associations shall work jointly and produce national and regional construction performance standards continually on yearly basis.

3. The Central Statistics Agency shall give due focus to prepare refined monthly consumer price index on construction materials, labor and equipments.

4. Contractors need to establish efficient and cost effective head office and project site organizational setups to minimize indirect costs and to create effective management chain both at the head office and project sites.

5. The current bid financial evaluation criteria is widely open for corruption and there are many instances whereby Engineer's estimates are prepared to favor certain contractors or certain contractors obtain the Engineer's estimates, which is the crucial basis to setup bidding strategies. Therefore, it is better to conduct proper technical evaluations and only contractors who can qualify to execute such kind of works shall compete based on their financial proposals.

6. The Ministry of Works and Urban Development in collaboration with project owners, contractors associations as well as consultants associations shall reward and publish annually list of both contractors and consultants with good performance in the construction industry.

7. Higher institutions shall incorporate appropriate construction cost estimation courses in their curriculums. Moreover, the government as well as professional associations shall organize from time to time different refresher courses and seminars on construction cost estimation for contractors and consultants.

8. Construction cost estimation requires analyzing extensive labor, equipment, material, head office and project site databases which makes it cumbersome and time taking. Therefore, the use of information technology in construction cost estimation shall be encouraged and strengthened.

9. In heavy construction projects such as road projects, equipment cost is the major cost component of the total project construction cost. Therefore, it is advantageous to purchase similar make equipments, which will largely simplify equipment operational and maintenance management. Moreover, price advantages and extra technical assistances can be obtained from manufacturers and suppliers.

10. Most contractors purchase heavy-duty construction equipments based on their initial purchase price. However, it is advisable that contractors shall purchase construction equipments based on the life cycle cost and life cycle production of the equipment.

11. Lack of competence in estimation and any information leakage on any one of the company construction cost database may result not only loosing specific tenders but also it can be a threat in securing future business. Therefore, it is very important that contractors need to have a clear tendering policy based on the organizational structure of their respective companies.

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DECLARATION

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university. All sources of materials used for the thesis have been duly acknowledged.

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