

PROJECT PLANNING AND MANAGEMENT

TECHNICAL ANALYSIS

Dr. Abenet Yohannes, Ph.D.

CHAPTER

5

Chapter Introduction

Technical analysis determines whether a proposed project can:

- Produce the intended product or service
- Achieve the required quality
- Operate at the planned capacity
- Obtain necessary inputs
- Use appropriate technology
- Be constructed and commissioned within a realistic schedule
- Operate at an acceptable cost

“

Can the proposed project be established and operated with the required technology, capacity, inputs, infrastructure, equipment and human resources?

Learning Objectives

By the end of this chapter, students will be able to:

- Explain the purpose of technical analysis
- Define product and service specifications
- Analyze manufacturing and service-delivery processes
- Evaluate alternative technologies
- Assess technical arrangements and technology transfer
- Determine an appropriate product mix
- Estimate plant capacity
- Assess material and input requirements
- Conduct location and site analysis
- Identify machinery and equipment requirements
- Estimate building and civil-work requirements
- Assess environmental implications
- Prepare project layouts and technical charts
- Develop an implementation work schedule
- Estimate the technical cost of the project
- Make a technical-feasibility recommendation

Chapter Roadmap

This chapter covers:

1. Technical-analysis framework
2. Manufacturing process and technology
3. Technical arrangements
4. Product mix
5. Plant capacity
6. Materials and inputs
7. Location and site
8. Machinery and equipment
9. Structures and civil works
10. Environmental aspects
11. Project charts and layouts
12. Work schedule
13. Cost of project
14. Technical risks and recommendation

Opening Reflection

Discussion Question

A project has:

- Strong demand
- Adequate financing
- Supportive government policy
- Experienced management

*However, its technology is untested, spare parts are unavailable and electricity supply is unreliable.
Should the project proceed?*

“

Technical analysis is the systematic examination of the physical, technological and operational requirements of a proposed project.

Purpose of Technical Analysis

Technical analysis determines:

- What will be produced
- How it will be produced
- How much will be produced
- Where production will occur
- Which inputs are required
- Which assets must be acquired
- How the project will be implemented

Relationship with Market Analysis

Market analysis determines:

- Customer needs
- Expected demand
- Required product quality
- Acceptable prices
- Expected sales

Technical analysis determines how the project will satisfy those market requirements.

Relationship with Financial Analysis

Technical analysis provides the foundation for estimating:

- Fixed investment
- Operating costs
- Labour costs
- Utility costs
- Maintenance costs
- Working capital
- Implementation expenditure

Technical Decisions Affect Financial Results

Technical choices influence:

- Initial investment
- Production efficiency
- Unit cost
- Product quality
- Capacity utilization
- Maintenance expenditure
- Project life
- Residual value

Main Technical Questions

- Is the selected process appropriate?
- Is the technology proven?
- Is capacity compatible with demand?
- Are raw materials available?
- Is the location suitable?
- Are utilities reliable?
- Can equipment be maintained?
- Is implementation time realistic?

Technical Study Outputs

The technical study should produce:

- Product specifications
- Process description
- Technology recommendation
- Capacity estimate
- Input schedule
- Location recommendation
- Machinery list
- Building requirements
- Layouts
- Work schedule
- Technical-cost estimate

Technical Analysis Is Iterative

Technical design may need revision when:

- Market forecasts change
- Financing is inadequate
- Technology is unavailable
- Environmental risks are excessive
- The proposed site is unsuitable
- Input supplies are insufficient

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A product specification defines the technical and quality characteristics of the proposed output.

Product-Specification Elements

Specifications may include:

- Product name
- Composition
- Dimensions
- Weight
- Performance
- Quality grade
- Packaging
- Shelf life
- Safety requirements
- Applicable standards

Service Specification

For a service project, specifications may include:

- Service scope
- Delivery process
- Operating hours
- Processing time
- Service capacity
- Accessibility
- Quality standard
- Customer-support requirements

Product Quality

The required quality level may be:

- Basic
- Standard
- Premium
- Export quality
- Regulatory minimum
- Customer-specific

Quality should be consistent with the target market and selling price.

Product Standardization

Standardization helps ensure:

- Consistent quality
- Easier procurement
- Interchangeable components
- Efficient production
- Simplified maintenance
- Regulatory compliance

Product Differentiation

Technical design may support differentiation through:

- Better performance
- Longer product life
- Superior materials
- Improved design
- Safer operation
- More convenient packaging
- Lower environmental impact

Product Specification Example

Poultry Feed

- Product type: Layer feed
- Moisture content: Within approved limit
- Nutritional composition: Defined formula
- Packaging: 50-kilogram bags
- Shelf life: Six months
- Label: Product type, batch, date and instructions

Service Specification Example

Medical Diagnostic Centre

- Operating hours: 12 hours daily
- Daily capacity: 200 patients
- Maximum waiting time: 45 minutes
- Test-result turnaround: 24 hours
- Quality-control system: Mandatory
- Digital patient records: Required

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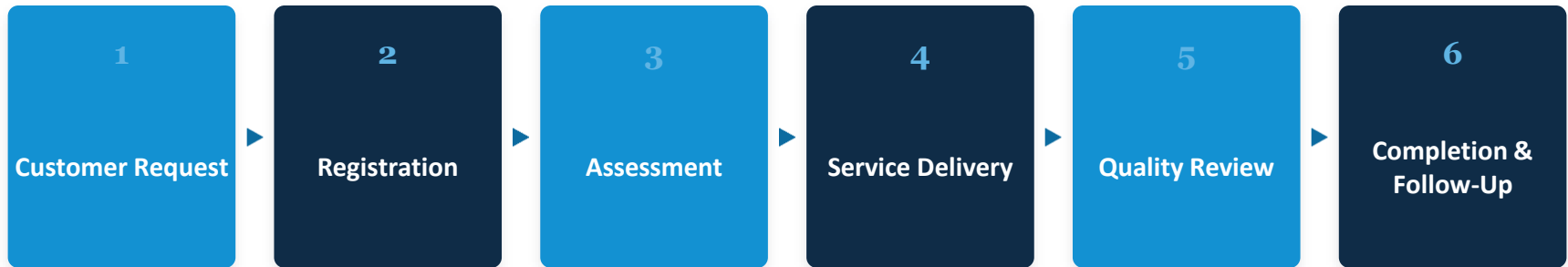
A manufacturing process is the sequence of activities through which raw materials and other inputs are transformed into finished products.

Basic Production Flow



Sequential flow of activities

Service-Delivery Flow



Sequential flow of activities

Process-Selection Questions

- Which steps are required?
- In what sequence should they occur?
- Which steps are automated?
- Which steps are manual?
- Where are inspections needed?
- Where may bottlenecks occur?
- What waste is generated?

Process Flowchart

A process flowchart presents:

- Inputs
- Activities
- Decision points
- Movement
- Inspection
- Storage
- Outputs
- Waste streams

Production-Process Example

Poultry-Feed Manufacturing

1. Receive ingredients
2. Inspect quality
3. Clean raw materials
4. Grind
5. Weigh ingredients
6. Mix
7. Add supplements
8. Pellet
9. Cool
10. Package
11. Store

Types of Production Process

Common process types include:

- Job production
- Batch production
- Mass production
- Continuous production
- Project production

Job Production

Job production creates customized outputs.

Examples:

- Custom furniture
- Specialized machinery
- Consulting assignments
- Tailored software
- Construction contracts

Batch Production

Batch production produces a specified quantity before changing to another product.

Examples:

- Bakery products
- Pharmaceuticals
- Garments
- Processed food
- Paint

Mass Production

Mass production produces large quantities of standardized products.

Characteristics:

- Repetitive operations
- Specialized machinery
- High volume
- Low variety
- Lower unit cost

Continuous Production

Continuous production operates without significant interruption.

Examples:

- Cement
- Petroleum
- Chemicals
- Electricity
- Water treatment

Process-Selection Factors

Select the process based on:

- Product design
- Output volume
- Product variety
- Quality requirements
- Flexibility
- Labour availability
- Technology
- Investment capacity

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A bottleneck is the stage with the lowest effective capacity.

It limits the output of the entire production system.

Bottleneck Example

A production line can:

- Grind 12 tonnes per hour
- Mix 10 tonnes per hour
- Pellet 8 tonnes per hour
- Package 6 tonnes per hour

The packaging stage limits production to approximately six tonnes per hour.

Process Yield

Process yield measures usable output obtained from the inputs used.

$$\text{Process Yield} = (\text{Good Output} \div \text{Total Input}) \times 100$$

Process-Yield Example

TOTAL INPUT
10,000 kg

USABLE OUTPUT
9,500 kg

$$Yield = (9,500 \div 10,000) \times 100$$

Yield = 95%

Process Loss

TOTAL INPUT
10,000 kg

USABLE OUTPUT
9,500 kg

$$\text{Process Loss} = \text{Total Input} - \text{Usable Output}$$

$$10,000 - 9,500 = 500 \text{ kilograms}$$

Process Improvement

Process efficiency may be improved through:

- Better layout
- Worker training
- Automation
- Waste reduction
- Quality controls
- Preventive maintenance
- Improved materials handling

What Is Technology?

Technology includes the:

- Knowledge
- Methods
- Equipment
- Software
- Skills
- Procedures

...used to produce the project's outputs.

Technology Alternatives

Technology may be:

- Manual
- Mechanized
- Semi-automated
- Fully automated
- Labour intensive
- Capital intensive
- Local
- Imported

Technology-Selection Criteria

Evaluate technology according to:

- Product quality
- Production capacity
- Investment cost
- Operating cost
- Reliability
- Flexibility
- Skill requirements
- Maintenance
- Environmental effect

Proven Technology

A proven technology has demonstrated satisfactory performance under similar operating conditions.

It reduces:

- Technical uncertainty
- Commissioning risk
- Quality risk
- Cost-overrun risk
- Implementation delays

New Technology

New technology may offer:

- Higher efficiency
- Better quality
- Lower energy use
- Reduced labour cost
- New products
- Competitive advantage

It may also involve greater uncertainty.

Labour-Intensive Technology

Advantages

- Greater employment creation
- Lower initial investment
- Easier local maintenance
- Greater operating flexibility

Limitations

- Variable quality
- Lower productivity
- Higher supervision
- Greater human-error risk

Capital-Intensive Technology

Advantages

- High productivity
- Consistent quality
- Faster production
- Lower labour cost per unit

Limitations

- High investment
- Skilled maintenance
- Foreign-exchange exposure
- Obsolescence risk

Appropriate Technology

Appropriate technology matches:

- Project scale
- Local conditions
- Available skills
- Input availability
- Financial capacity
- Maintenance capability
- Environmental requirements

Local versus Imported Technology

Local Technology	Imported Technology
Easier local support	May provide advanced performance
Lower foreign-exchange needs	May require foreign currency
Faster spare-parts access	Spare parts may be delayed
May have limited capacity	May offer larger capacity

Technology-Selection Matrix

Criterion	Weight	Option A	Option B	Option C
Investment cost	20%			
Operating cost	15%			
Quality	20%			
Reliability	15%			
Maintenance	10%			
Skill requirement	10%			
Environmental effect	10%			

Score each option against the weighted criteria and total the results.

Technology Obsolescence

Technology may become obsolete because of:

- Rapid innovation
- Regulatory changes
- New product standards
- Changing customer preferences
- Discontinued supplier support
- More efficient alternatives

Technology Pilot Testing

Before full investment, the project may use:

- Demonstration
- Prototype
- Pilot plant
- Trial production
- Supplier reference visit
- Independent technical review

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Technical arrangements define how the project will obtain, install, operate and maintain the selected technology.

Possible Technical Arrangements

Arrangements may include:

- Technology licensing
- Turnkey contract
- Technical collaboration
- Engineering consultancy
- Equipment-supply agreement
- Management contract
- Training agreement
- Maintenance contract

Technology Licensing

A licensing agreement permits the project to use:

- Patents
- Designs
- Processes
- Formulas
- Software
- Technical knowledge

...in return for agreed compensation.

Licensing Considerations

Assess:

- Licence duration
- Geographic rights
- Royalty
- Confidentiality
- Technical support
- Restrictions
- Ownership of improvements
- Termination conditions

Turnkey Contract

Under a turnkey arrangement, a contractor may be responsible for:

- Design
- Procurement
- Construction
- Equipment installation
- Testing
- Commissioning

The completed facility is handed over ready for operation.

Turnkey Advantages

- Single-point responsibility
- Better coordination
- Defined completion obligation
- Reduced interface risk
- Faster implementation potential

Turnkey Limitations

- Higher contract price
- Dependence on contractor
- Reduced owner learning
- Limited design flexibility
- Risk of weak technical transfer

Technical Collaboration

Technical collaboration may provide:

- Production know-how
- Product design
- Quality standards
- Training
- Process improvement
- Maintenance support

Technology-Transfer Requirements

Effective technology transfer may require:

- Manuals
- Engineering drawings
- Staff training
- On-site experts
- Trial operation
- Documentation
- Performance guarantees
- Knowledge-transfer milestones

Performance Guarantee

A technology supplier may guarantee:

- Output capacity
- Product quality
- Input consumption
- Energy efficiency
- Waste level
- Equipment availability

Warranty

A warranty should specify:

- Covered equipment
- Warranty period
- Exclusions
- Repair responsibility
- Replacement terms
- Response time
- Location of service

After-Sales Support

Assess whether the supplier provides:

- Local technicians
- Remote support
- Spare parts
- Emergency maintenance
- Software updates
- Refresher training

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Product mix is the combination of products or services the project proposes to offer.

Product-Mix Example

A dairy-processing project may produce:

- Pasteurized milk
- Yogurt
- Butter
- Cheese
- Cream
- Flavoured milk

Product-Mix Decisions

Product-mix decisions should consider:

- Market demand
- Production compatibility
- Raw-material use
- Profit margins
- Equipment requirements
- Storage
- Quality control
- Seasonality

Advantages of Product Diversification

A broader product mix may:

- Reduce market risk
- Improve capacity utilization
- Use by-products
- Serve different segments
- Increase revenue
- Reduce seasonality

Product-Mix Complexity

A broad mix may also increase:

- Investment cost
- Operational complexity
- Inventory
- Quality-control requirements
- Scheduling difficulty
- Marketing expenditure

Product-Mix Optimization

Management should select a mix that balances:

- Market attractiveness
- Contribution margin
- Production capacity
- Input limitations
- Risk
- Strategic objectives

By-Products

By-products may:

- Generate additional revenue
- Reduce waste-disposal costs
- Improve resource efficiency
- Create new market opportunities

By-Product Example

An oil-processing project may generate:

- Oil
- Oilseed cake
- Soap-making inputs
- Organic residue
- Fuel material

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Plant capacity is the quantity of output a facility can produce during a specified period.

Types of Capacity

- Design capacity
- Installed capacity
- Effective capacity
- Normal capacity
- Actual production
- Economic capacity

“

Design capacity is the maximum theoretical output under ideal operating conditions.

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Installed capacity is the maximum output supported by the installed machinery and equipment.

Effective Capacity

Effective capacity reflects practical operating conditions, including:

- Maintenance
- Set-up time
- Breaks
- Quality losses
- Working hours
- Input interruptions

Actual Output

Actual output is the quantity produced during a specific period.

It may differ from capacity because of:

- Weak demand
- Breakdowns
- Input shortages
- Power interruption
- Labour problems

Capacity Utilization

$$\text{Capacity Utilization} = (\text{Actual Output} \div \text{Installed Capacity}) \times 100$$

Capacity-Utilization Example

INSTALLED CAPACITY
20,000 tonnes

ACTUAL OUTPUT
15,000 tonnes

$$\text{Capacity Utilization} = (15,000 \div 20,000) \times 100$$

Capacity Utilization = 75%

Capacity-Determination Factors

Capacity depends on:

- Market demand
- Input availability
- Technology
- Finance
- Minimum economic size
- Utilities
- Labour
- Management capability
- Future expansion

Market-Based Capacity

Capacity should generally be consistent with:

- Forecast sales
- Market share
- Sales ramp-up
- Competitive conditions
- Distribution capacity

Input-Constrained Capacity

Capacity may be restricted by:

- Raw-material supply
- Seasonal availability
- Water
- Electricity
- Labour
- Transport
- Storage

Minimum Economic Size

Minimum economic size is the smallest capacity at which the project can operate competitively.
Below this level:

- Unit costs may be high
- Equipment may be inefficient
- Fixed costs may be excessive
- Profitability may be weak

Economies of Scale

Economies of scale occur when average cost declines as output increases.

Sources include:

- Fixed-cost spreading
- Specialized machinery
- Bulk purchasing
- Labour specialization
- Distribution efficiency

Diseconomies of Scale

Excessive size may cause:

- Management complexity
- Communication problems
- High transport costs
- Weak control
- Excess capacity
- Increased implementation risk

Capacity Cushion

A capacity cushion is additional capacity above expected demand.

It protects the project against:

- Seasonal peaks
- Demand growth
- Equipment downtime
- Forecast errors
- Emergency requirements

Phased Capacity

A project may install capacity in phases.

Advantages:

- Lower initial investment
- Reduced demand risk
- Learning before expansion
- Better cash-flow alignment

Capacity Ramp-Up

A new project may forecast:

- Year 1: 60%
- Year 2: 70%
- Year 3: 80%
- Year 4: 90%
- Year 5: 95%

The rates should reflect market and operational realities.

Capacity Calculation

If annual demand available to the project is 20,000 tonnes:

ANNUAL DEMAND
20,000 tonnes

WORKING DAYS
300

HOURS PER DAY
8

$$\text{Required Hourly Output} = 20,000 \div (300 \times 8)$$

≈ 8.33 tonnes per hour

Capacity with Downtime Allowance

OPERATING AVAILABILITY

85%

$$\text{Required Installed Capacity} = 8.33 \div 0.85$$

≈ 9.8 tonnes per hour

A 10-tonne-per-hour plant may therefore be considered.

Main Project Inputs

Inputs may include:

- Raw materials
- Components
- Packaging
- Chemicals
- Fuel
- Water
- Electricity
- Information
- Specialized services

Input-Assessment Criteria

Assess each input according to:

- Quantity
- Quality
- Price
- Source
- Reliability
- Seasonality
- Lead time
- Storage requirements
- Alternatives

Raw-Material Requirement

$$\text{Annual Material Requirement} = \text{Annual Output} \times \text{Material Required per Unit}$$

Raw-Material Example

ANNUAL FEED OUTPUT
20,000 tonnes

MAIZE PER TONNE
0.60 tonnes

$$\text{Annual Maize Requirement} = 20,000 \times 0.60$$

Annual Maize Requirement = 12,000 tonnes

Input-Conversion Ratio

$$\text{Input-Output Ratio} = \text{Quantity of Input} \div \text{Quantity of Output}$$

It supports input planning and efficiency analysis.

Allowance for Waste

Input estimates should include losses from:

- Spoilage
- Damage
- Evaporation
- Cutting
- Quality rejection
- Start-up operations
- Handling

Adjusted Input Requirement

$$\text{Adjusted Requirement} = \text{Net Requirement} \div (1 - \text{Loss Rate})$$

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Loss-Rate Example

NET REQUIREMENT
10,000 units

EXPECTED LOSS
5%

$$\text{Adjusted Requirement} = 10,000 \div 0.95$$

$\approx 10,526$ units

Raw-Material Quality

Poor-quality inputs may result in:

- Product defects
- Low yield
- Equipment damage
- Increased waste
- Customer complaints
- Regulatory noncompliance

Seasonal Inputs

Seasonal raw materials may require:

- Bulk purchasing
- Storage
- Preservation
- Additional working capital
- Alternative suppliers
- Production scheduling

Supplier Analysis

Assess suppliers according to:

- Capacity
- Quality
- Price
- Delivery
- Financial stability
- Credit terms
- Geographic location
- Past performance

Single-Supplier Risk

Dependence on one supplier may cause:

- Supply interruption
- High prices
- Weak bargaining position
- Quality risk
- Delivery delays

Supplier Diversification

Diversification may involve:

- Multiple local suppliers
- Regional sourcing
- Import alternatives
- Long-term contracts
- Support for supplier development
- Buffer stock

Packaging Materials

Packaging analysis should consider:

- Product protection
- Cost
- Availability
- Customer preference
- Transport
- Labelling
- Environmental impact
- Regulatory standards

Inventory Requirements

Input planning should determine:

- Minimum stock
- Safety stock
- Reorder level
- Lead time
- Storage capacity
- Working-capital requirement

Utility Requirements

Projects may require:

- Electricity
- Water
- Fuel
- Gas
- Steam
- Compressed air
- Telecommunications
- Internet
- Refrigeration

Electricity Assessment

Assess:

- Connected load
- Peak demand
- Voltage
- Reliability
- Tariff
- Connection cost
- Backup requirement
- Expansion capacity

Electricity Requirement

The project should estimate power demand for:

- Production machinery
- Lighting
- Cooling
- Heating
- Offices
- Water pumping
- Security systems
- Waste treatment

Backup Power

Possible backup systems include:

- Generator
- Solar energy
- Battery storage
- Dual-grid connection
- Hybrid energy system

Water Assessment

Assess:

- Daily quantity
- Quality
- Source
- Reliability
- Treatment
- Storage
- Disposal
- Cost

Water-Requirement Example

DAILY OUTPUT
5,000 units

WATER PER UNIT
4 litres

$$\text{Daily Water Requirement} = 5,000 \times 4$$

Daily Water Requirement = 20,000 litres

Transport Infrastructure

Assess:

- Road access
- Road condition
- Seasonal accessibility
- Rail access
- Airport access
- Port access
- Travel time
- Transport cost

Communication Infrastructure

Projects may require:

- Reliable internet
- Mobile coverage
- Data systems
- Cloud services
- Security systems
- Technical support
- Backup communication

Location versus Site

Location

The broad geographic area where the project will operate.

Site

The specific plot of land or facility selected within the location.

Importance of Location

Location affects:

- Market access
- Raw-material access
- Transport costs
- Labour availability
- Utilities
- Land cost
- Security
- Environmental impact
- Profitability

Location Factors

Consider:

- Proximity to market
- Proximity to raw materials
- Transport
- Labour
- Utilities
- Government policy
- Community acceptance
- Climate
- Environmental conditions

Market-Oriented Location

A market-oriented location is appropriate when:

- Products are perishable
- Delivery speed is important
- Transport cost is high
- Customer contact is essential
- Services require accessibility

Raw-Material-Oriented Location

This may be appropriate when:

- Raw materials are bulky
- Inputs are perishable
- Processing reduces weight
- Input sources are geographically concentrated

Labour-Oriented Location

Labour considerations are important when the project requires:

- Large labour force
- Specialized skills
- Low-cost labour
- Technical professionals
- Stable workforce

Government Policy and Location

Government may influence location through:

- Industrial zones
- Land allocation
- Tax incentives
- Regional-development priorities
- Licensing
- Infrastructure support
- Environmental restrictions

Community Considerations

Assess:

- Community support
- Land ownership
- Employment expectations
- Cultural sites
- Security
- Resettlement
- Resource competition
- Grievance risks

Location-Scoring Method

$$\text{Weighted Location Score} = \Sigma (\text{Factor Weight} \times \text{Site Rating})$$

Location-Scoring Matrix

Factor	Weight	Site A	Site B	Site C
Market access	20%			
Raw-material access	20%			
Transport	15%			
Utilities	15%			
Labour	10%			
Land cost	10%			
Environmental risk	10%			

Rate each site against every factor, then combine the weighted scores.

Site-Selection Factors

Assess:

- Land size
- Topography
- Soil
- Drainage
- Road access
- Utilities
- Legal title
- Expansion space
- Environmental sensitivity
- Construction suitability

Land Requirements

Land may be required for:

- Production
- Warehousing
- Offices
- Utilities
- Internal roads
- Parking
- Waste treatment
- Safety zones
- Future expansion

Site Due Diligence

Before acquisition, verify:

- Ownership
- Boundaries
- Existing users
- Encumbrances
- Zoning
- Environmental restrictions
- Resettlement implications
- Access rights

Equipment Requirements

Equipment should be derived from:

- Product specifications
- Process flow
- Technology
- Capacity
- Quality standards
- Utility availability
- Safety requirements

Equipment Categories

A project may require:

- Production machinery
- Material-handling equipment
- Testing equipment
- Packaging equipment
- Vehicles
- Office equipment
- Safety equipment
- Backup systems

Equipment-Selection Criteria

Evaluate:

- Capacity
- Purchase price
- Output quality
- Energy consumption
- Reliability
- Useful life
- Maintenance
- Spare parts
- Supplier support

New versus Used Equipment

New Equipment

- Warranty
- Better reliability
- Modern technology
- Higher cost

Used Equipment

- Lower initial cost
- Possible hidden defects
- Shorter useful life
- Limited warranty

Total Equipment Cost

Equipment cost may include:

- Purchase price
- Freight
- Insurance
- Customs duty
- Inland transport
- Installation
- Testing
- Training
- Initial spare parts

Landed Equipment Cost

$$\text{Landed Cost} = \text{Purchase Price} + \text{Freight} + \text{Insurance} \\ + \text{Customs} + \text{Transport} + \text{Installation}$$

Supplier Evaluation

Supplier evaluation should consider:

- Technical competence
- Financial stability
- Delivery record
- Warranty
- Spare parts
- Local representation
- Training
- Customer references

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Production equipment should be balanced.

If one machine has substantially lower capacity, it may become a bottleneck.

Equipment Availability

$$\text{Equipment Availability} = \left(\frac{\text{Available Operating Time}}{\text{Scheduled Operating Time}} \right) \times 100$$

Equipment-Availability Example

SCHEDULED TIME
2,000 hours

DOWNTIME
200 hours

AVAILABLE TIME
1,800 hours

$$\text{Availability} = (1,800 \div 2,000) \times 100$$

Availability = 90%

Maintenance Requirements

Maintenance may be:

- Routine
- Preventive
- Corrective
- Predictive
- Emergency

Preventive Maintenance

Preventive maintenance provides:

- Reduced breakdown
- Longer useful life
- Better safety
- Stable quality
- Reduced emergency cost
- Improved equipment availability

Spare-Parts Planning

Identify:

- Critical spare parts
- Consumption rate
- Lead time
- Supplier
- Minimum stock
- Storage
- Foreign-exchange needs

Building Requirements

Buildings may include:

- Production facility
- Warehouse
- Administrative office
- Laboratory
- Workshop
- Utility building
- Staff facilities
- Security post

Civil-Work Requirements

Civil works may include:

- Site preparation
- Foundations
- Drainage
- Internal roads
- Fencing
- Water systems
- Waste systems
- Landscaping

Building-Design Factors

Design should consider:

- Process flow
- Equipment size
- Worker safety
- Lighting
- Ventilation
- Expansion
- Fire protection
- Hygiene
- Maintenance access

Warehouse Design

Warehouse design should consider:

- Material volume
- Product type
- Storage duration
- Temperature
- Humidity
- Movement
- Safety
- Inventory control

Utility Buildings

Separate facilities may be needed for:

- Generator
- Transformer
- Boiler
- Water treatment
- Refrigeration
- Waste treatment
- Fuel storage

Building-Cost Estimate

Building cost may be estimated as:

$$\textit{Building Cost} = \textit{Floor Area} \times \textit{Construction Cost per Square Metre}$$

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Building-Cost Example

FLOOR AREA

2,000 m²

COST PER M²

ETB 25,000

$$\text{Estimated Cost} = 2,000 \times 25,000$$

Estimated Cost = ETB 50,000,000

Construction Contingency

Contingency may cover:

- Quantity changes
- Soil conditions
- Design adjustments
- Material-price changes
- Additional safety requirements
- Weather delays

Environmental Considerations

Technical design should assess:

- Air emissions
- Wastewater
- Solid waste
- Noise
- Land use
- Water use
- Energy use
- Biodiversity
- Climate risk

Pollution Sources

Pollution may arise from:

- Production process
- Fuel combustion
- Chemicals
- Waste disposal
- Vehicle movement
- Storage
- Equipment cleaning
- Accidental spills

Waste Management

The technical plan should address:

- Waste identification
- Segregation
- Storage
- Reuse
- Recycling
- Treatment
- Disposal
- Documentation

Waste Hierarchy

Preferred order:

1. Prevent
2. Reduce
3. Reuse
4. Recycle
5. Recover
6. Treat
7. Dispose

Wastewater Management

Assess:

- Quantity
- Composition
- Treatment requirement
- Discharge point
- Reuse potential
- Legal standards
- Monitoring

Energy Efficiency

Energy efficiency may be improved through:

- Efficient machinery
- Variable-speed motors
- Heat recovery
- Insulation
- Solar power
- Preventive maintenance
- Efficient lighting

Cleaner Production

Cleaner production aims to:

- Reduce input consumption
- Minimize waste
- Prevent pollution
- Improve productivity
- Reduce cost
- Improve safety

Climate Risk

Technical design should assess exposure to:

- Flood
- Drought
- Extreme heat
- Water scarcity
- Storm
- Changing rainfall
- Supply-chain disruption

Environmental-Mitigation Cost

Environmental-management requirements should be incorporated into:

- Equipment cost
- Civil works
- Operating cost
- Staffing
- Monitoring budget
- Closure cost

Purpose of Technical Charts

Technical charts help communicate:

- Process sequence
- Material flow
- Equipment relationships
- Space requirements
- Implementation logic
- Organizational responsibility

Main Technical Charts

A technical study may include:

- Process flowchart
- Material-flow diagram
- Plant layout
- Site layout
- Equipment layout
- Utility diagram
- Organization chart
- Work schedule

Process Flowchart

A process flowchart shows how materials move through:

- Receiving
- Processing
- Inspection
- Packaging
- Storage
- Dispatch

Material-Flow Diagram

A material-flow diagram shows:

- Input entry
- Material movement
- Intermediate storage
- Processing stages
- Output exit
- Waste movement

Plant Layout

Plant layout determines the physical arrangement of:

- Machinery
- Workstations
- Storage
- Quality-control points
- Utilities
- Worker movement
- Emergency exits

Layout Objectives

A good layout seeks to:

- Minimize movement
- Reduce handling cost
- Prevent congestion
- Improve safety
- Support supervision
- Improve quality
- Allow expansion

Product Layout

Machines are arranged according to the production sequence.

Suitable for:

- High-volume production
- Standardized products
- Continuous processes

Process Layout

Similar equipment or activities are grouped together.

Suitable for:

- Product variety
- Batch production
- Workshops
- Hospitals
- Customized services

Fixed-Position Layout

The project output remains in one location while workers and equipment move around it.

Examples:

- Building construction
- Shipbuilding
- Large infrastructure
- Aircraft assembly

Site Layout

The site layout should show:

- Buildings
- Roads
- Parking
- Storage
- Utilities
- Waste facilities
- Security
- Expansion area
- Emergency access

Layout-Safety Considerations

A safe layout should include:

- Emergency exits
- Fire access
- Separation of hazardous materials
- Safe pedestrian routes
- Ventilation
- Machine clearances
- Assembly points

“

A work schedule presents the timing and sequence of activities required to establish and commission the project.

Main Implementation Activities

Typical activities include:

- Detailed design
- Land acquisition
- Licensing
- Financing
- Procurement
- Construction
- Equipment delivery
- Installation
- Recruitment
- Training
- Testing
- Commissioning

Activity Sequencing

Activities may be:

- Sequential
- Parallel
- Dependent
- Independent
- Conditional

Work Breakdown Structure

The technical work may be divided into:

- Design
- Civil works
- Machinery procurement
- Utility installation
- Equipment installation
- Staffing
- Trial production
- Handover

Gantt Chart

Activity	M1	M2	M3	M4	M5	M6
Design						
Procurement						
Construction						
Installation						
Training						

Shaded cells indicate the months in which each activity is active.

Project Milestones

Milestones may include:

- Land secured
- Design approved
- Financing confirmed
- Construction completed
- Equipment delivered
- Installation completed
- Trial production completed
- Commercial operation started

“

The critical path is the longest sequence of dependent activities determining the minimum project-completion time.

A delay in a critical activity may delay the entire project.

Implementation Lead Times

Lead times should be estimated for:

- Design approval
- Tendering
- Equipment manufacture
- International shipping
- Customs clearance
- Construction
- Installation
- Testing

Schedule Risk

The work schedule may be affected by:

- Financing delay
- Permit delay
- Supplier failure
- Customs clearance
- Weather
- Contractor performance
- Utility connection
- Security

Schedule Contingency

Reasonable contingency may be included for:

- Imported-equipment delays
- Weather
- Regulatory approvals
- Construction risks
- Testing and rework

Trial Production

Trial production helps verify:

- Equipment operation
- Product quality
- Process yield
- Staff competence
- Input requirements
- Utility consumption
- Production speed

Commissioning

Commissioning confirms that:

- Equipment is installed correctly
- Systems operate together
- Output meets specifications
- Safety systems function
- Operators are trained
- Performance guarantees are achieved

“

The technical study should provide a comprehensive estimate of the investment required to establish the project.

Main Cost Categories

Project costs may include:

- Land and site development
- Buildings and civil works
- Machinery and equipment
- Vehicles
- Technical know-how
- Installation
- Preliminary expenses
- Pre-operating expenses
- Contingency
- Working capital

Land and Site-Development Cost

Costs may include:

- Land purchase or lease
- Legal fees
- Registration
- Site clearing
- Grading
- Drainage
- Access road
- Fencing

Buildings and Civil-Work Cost

Include:

- Production building
- Warehouse
- Administration
- Laboratory
- Utility buildings
- Internal roads
- Water systems
- Waste systems

Machinery and Equipment Cost

Include:

- Purchase price
- Freight
- Insurance
- Customs
- Inland transport
- Installation
- Testing
- Training
- Initial spare parts

Technical Know-How Cost

Possible costs include:

- Licence fee
- Royalty
- Engineering services
- Technical assistance
- Documentation
- Specialist training
- Commissioning support

Preliminary Expenses

Preliminary costs may include:

- Feasibility study
- Engineering design
- Market study
- Environmental assessment
- Legal registration
- Project-development consultancy

Pre-Operating Expenses

Pre-operating expenses may include:

- Recruitment
- Training
- Trial production
- Temporary salaries
- Initial promotion
- Office expenses
- Start-up utilities

Physical Contingency

Physical contingency covers:

- Quantity variation
- Design adjustments
- Additional materials
- Unforeseen site conditions
- Installation changes

Price Contingency

Price contingency covers possible increases in:

- Equipment
- Construction materials
- Labour
- Transport
- Exchange rates
- Inflation

Total Project Cost

$$\begin{aligned} \text{Total Project Cost} = & \text{Land} + \text{Civil Works} + \text{Equipment} \\ & + \text{Installation} + \text{Pre-Operating Costs} \\ & + \text{Contingency} + \text{Working Capital} \end{aligned}$$

Project-Cost Table

Cost Category	Estimated Cost
Land and site development	
Buildings and civil works	
Machinery and equipment	
Vehicles	
Technical know-how	
Preliminary expenses	
Pre-operating expenses	
Contingency	
Working capital	
Total Project Cost	

Local and Foreign-Currency Costs

Project costs should be separated into:

Local Currency

- Local construction
- Local labour
- Domestic transport
- Local materials

Foreign Currency

- Imported equipment
- Foreign consultancy
- Software
- Spare parts
- Licensing

Base Cost and Escalation

The estimate should clearly distinguish:

- Base price
- Taxes
- Freight
- Installation
- Physical contingency
- Price escalation
- Exchange-rate assumption

Avoiding Double Counting

The same item should not be recorded under multiple categories.

Examples:

- Freight included both in equipment and logistics
- Installation included in supplier price and separately
- Training included in equipment and pre-operating cost

Major Technical Risks

Technical risks may include:

- Technology failure
- Capacity shortfall
- Equipment breakdown
- Input shortage
- Utility interruption
- Quality failure
- Skill shortage
- Construction delay
- Cost overrun

Technology Risk

Technology risk increases when:

- Technology is untested
- Supplier support is limited
- Local adaptation is required
- Skills are unavailable
- Technology changes rapidly
- Performance guarantees are weak

Capacity Risk

Capacity risk may arise from:

- Excessive project size
- Demand overestimation
- Bottlenecks
- Poorly matched equipment
- Limited utilities
- Input constraints

Input Risk

Input risk may arise from:

- Seasonal shortages
- Supplier concentration
- Import restrictions
- Quality variation
- Price volatility
- Transport disruption

Utility Risk

Utility risks include:

- Power failure
- Water shortage
- Fuel scarcity
- Internet disruption
- High tariffs
- Inadequate grid capacity

Construction Risk

Construction risks may include:

- Design errors
- Cost escalation
- Contractor failure
- Poor workmanship
- Weather
- Material shortage
- Site conditions

Technical-Risk Responses

Possible responses include:

- Proven technology
- Pilot testing
- Supplier guarantees
- Multiple suppliers
- Backup utilities
- Preventive maintenance
- Spare-parts inventory
- Staff training
- Phased capacity

Technical Sensitivity Analysis

Test project performance under:

- Capacity 20% below plan
- Equipment cost 20% higher
- Input consumption 10% higher
- Energy cost doubled
- Construction delayed six months
- Product loss above forecast

MBA Case Exercise

Proposed Poultry-Feed Plant

Annual planned capacity: 20,000 tonnes

Proposed products:

- Layer feed
- Chick feed
- Broiler starter
- Broiler finisher

Process Design

The proposed process includes:

1. Raw-material receiving
2. Quality inspection
3. Cleaning
4. Grinding
5. Weighing
6. Mixing
7. Pelleting
8. Cooling
9. Packaging
10. Storage

Technology Alternatives

Option A

Locally produced manual and semi-mechanized equipment.

Option B

Semi-automated imported production line.

Option C

Fully automated imported production system.

Technology-Evaluation Exercise

Compare the options based on:

- Investment cost
- Output capacity
- Product quality
- Operating cost
- Reliability
- Skill requirements
- Maintenance
- Spare parts

Capacity Calculation

ANNUAL OUTPUT
20,000 tonnes

WORKING DAYS
300

DAILY HOURS
8

$$\text{Required Hourly Output} = 20,000 \div (300 \times 8)$$

Required Hourly Output = 8.33 tonnes

Capacity with Operational Allowance

PLANT AVAILABILITY

85%

$$\text{Installed Capacity} = 8.33 \div 0.85$$

≈ 9.8 tonnes per hour

Recommended nominal capacity: 10 tonnes per hour.

Product-Mix Exercise

Assume:

- Layer feed: 40%
- Broiler starter: 20%
- Broiler finisher: 25%
- Chick feed: 15%

Calculate annual production by product.

Product-Mix Solution

ANNUAL CAPACITY

20,000 tonnes

Layer feed = $20,000 \times 40\% = 8,000$ tonnes

Broiler starter = $20,000 \times 20\% = 4,000$ tonnes

Broiler finisher = $20,000 \times 25\% = 5,000$ tonnes

Chick feed = $20,000 \times 15\% = 3,000$ tonnes

Raw-Material Formula

Assume each tonne requires:

- Maize: 60%
- Soybean meal: 20%
- Wheat bran: 15%
- Supplements: 5%

Annual Material Requirements

Material	Percentage	Annual Requirement
Maize	60%	12,000 tonnes
Soybean meal	20%	4,000 tonnes
Wheat bran	15%	3,000 tonnes
Supplements	5%	1,000 tonnes

Location Exercise

Assess three potential sites according to:

- Raw-material access
- Customer access
- Electricity
- Water
- Road access
- Labour
- Land cost
- Environmental risk

Machinery Requirements

The project may require:

- Hammer mill
- Mixer
- Pellet machine
- Cooling system
- Conveyors
- Weighing machines
- Packaging machine
- Laboratory equipment
- Generator

Building Requirements

Possible facilities include:

- Production building
- Raw-material warehouse
- Finished-goods warehouse
- Laboratory
- Administration office
- Maintenance workshop
- Utility area

Environmental Issues

Possible impacts include:

- Dust
- Noise
- Solid waste
- Packaging waste
- Worker injury
- Transport traffic
- Energy consumption

Implementation Schedule

Activity	Duration
Detailed design	2 months
Licensing and financing	3 months
Procurement	4 months
Construction	6 months
Installation	2 months
Recruitment and training	2 months
Trial production	1 month

Some activities may overlap.

Technical-Risk Exercise

Assess:

- Imported-equipment delay
- Raw-material shortage
- Electricity interruption
- Skill shortage
- Equipment breakdown
- Product-quality failure
- Construction overrun

Group Assignment

Each group should prepare:

1. Product specifications
2. Process flowchart
3. Technology alternatives
4. Technology-selection matrix
5. Product-mix plan
6. Capacity calculation
7. Input-requirement schedule
8. Location-scoring matrix
9. Machinery list
10. Building requirements
11. Plant layout
12. Implementation schedule
13. Technical-cost estimate
14. Technical-risk register
15. Final recommendation

Common Technical-Analysis Mistakes

- Selecting technology before defining the product
- Choosing excessive capacity
- Ignoring production bottlenecks
- Underestimating material losses
- Ignoring seasonal inputs
- Selecting equipment without maintenance support
- Ignoring utility interruptions
- Choosing land without due diligence
- Omitting installation and training costs
- Using an unrealistic implementation schedule

Technical-Analysis Checklist

Confirm that:

- Product specifications are clear
- Production process is defined
- Technology alternatives are compared
- Technical arrangements are documented
- Product mix is justified
- Capacity reflects market demand
- Inputs are available
- Location and site are suitable
- Equipment requirements are complete
- Civil works are estimated
- Environmental requirements are addressed
- Layouts are prepared
- Schedule is realistic
- Costs are comprehensive
- Risks are manageable

Knowledge Check

1. What is technical analysis?
2. Why are product specifications necessary?
3. What is a production bottleneck?
4. What factors affect technology selection?
5. What is appropriate technology?
6. What is a turnkey arrangement?
7. What is product mix?
8. How is capacity utilization calculated?
9. What is minimum economic size?
10. How are annual material requirements estimated?
11. How does location differ from site?
12. What costs form landed equipment cost?
13. Why are project layouts required?
14. What is commissioning?

Knowledge Check — Answers

1. Assessment of the physical and technological requirements of a project
2. They define the quality and technical characteristics of the output
3. The process stage that limits total production
4. Cost, quality, capacity, reliability, skills, maintenance and environment
5. Technology suited to project scale and local operating conditions
6. A contractor delivers a complete facility ready for operation
7. Combination of products or services offered
8. Actual output divided by installed capacity
9. Smallest capacity that can operate competitively
10. Annual output multiplied by input required per unit
11. Location is the broad area; site is the specific plot
12. Purchase, freight, insurance, customs, transport and installation
13. To organize process, equipment, materials and movement efficiently
14. Testing and confirming that the completed system performs as required

Individual Assignment

Select one proposed project and prepare:

- Product or service specifications
- Process description
- Process flowchart
- Technology alternatives
- Recommended technology
- Technical-arrangement requirements
- Product mix
- Capacity calculation
- Material and input estimates
- Utility requirements
- Location analysis
- Site-selection criteria
- Machinery and equipment list
- Structures and civil works
- Environmental requirements
- Plant or service layout
- Implementation schedule
- Project-cost estimate
- Technical-risk analysis
- Final technical-feasibility conclusion

Chapter Summary

- Technical analysis determines whether a project can be physically established and operated.
- Product specifications define required output characteristics.
- Process analysis explains how inputs become outputs.
- Technology should match quality, capacity and local conditions.
- Technical arrangements govern technology acquisition, transfer and support.
- Product mix should balance market demand and production capability.
- Plant capacity should be consistent with market size and input availability.
- Material estimates should include losses, quality and seasonality.
- Location affects market access, inputs, utilities and costs.
- Equipment selection should consider total acquisition and maintenance costs.
- Buildings and civil works should support process flow and safety.
- Environmental requirements must be integrated into technical design.
- Layouts improve movement, efficiency, supervision and safety.
- The work schedule should account for dependencies and lead times.
- Technical cost estimates should include all investment and start-up requirements.
- Technical risks should be identified before the final investment decision.

Technical analysis transforms a market opportunity into a practical production or service-delivery system.

Specifications → Process → Technology → Product Mix → Capacity → Inputs →
Location → Equipment → Layout → Schedule → Cost → Decision

Next Chapter Preview

Next Chapter — Financial Estimates and Projections

The next chapter will cover:

- Cost of project
- Means of finance
- Estimates of sales and production
- Cost of production
- Working-capital requirement
- Projected profitability
- Projected cash flow
- Projected balance sheet
- Break-even point
- Debt-service capacity
- Financial assumptions

QUESTIONS & DISCUSSION

THANK YOU

Dr Abenet Yohannes, Ph.D.

MBA-525 — Project Planning and Management

Master of Business Administration · Jigjiga University

Email: abenetyohannes@gmail.com

Technical analysis converts project concepts into practical operating systems — integrating appropriate technology, realistic capacity, reliable inputs, suitable location, maintainable equipment and disciplined implementation planning.