Program Magister Teknik dan Manajemen Industri ITB

KULIAH 4
METODOLOGI DAN DISAIN RISET KUANTITATIF

Tujuan dan Pokok Bahasan

Tujuan

- Memahami metodologi penyelesaian masalah dalam sistem integral, khususnya dengan pendekatan sistemik terintegrasi

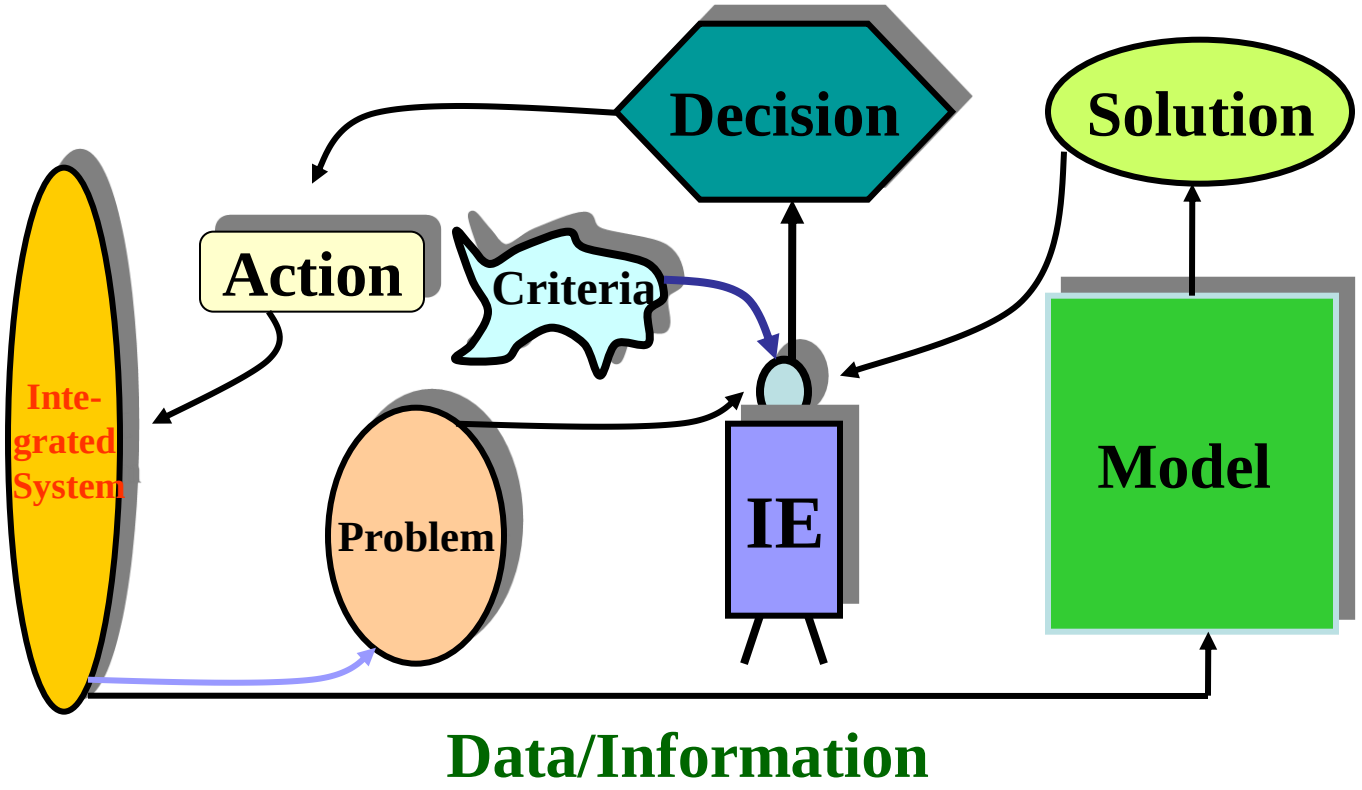
Pokok Bahasan

1. Problem Solving Approach
2. Management Science Approach:
   - Quantitative Approach: Inventory Model
   - Operation Reserach Approach
   - Simulation Approach
3. Integrated Approach

Problem Solving Approach

Scientific Method	Analytical Thinking	Creative Thinking	Creative Problem Solving	Management Science Integrated
Deductive data analysis & hypothesis	Define and sketch system Identify un-kown	Exploration of resources	Problem definition	Problem definition
Deduction of possible solution	Model the problem	Incubation possibilities	Idea generation Idea evaluation	Modeling
Test alternative solution	Conduct analysis & experiment	illumination and decision making	Idea judgment & decision making	Decision Making
Implementation best solution	Evaluate final result & implementation	Verification and Modification	Implementation & follow up	Implementation & Improvement

IE and its Integrated System



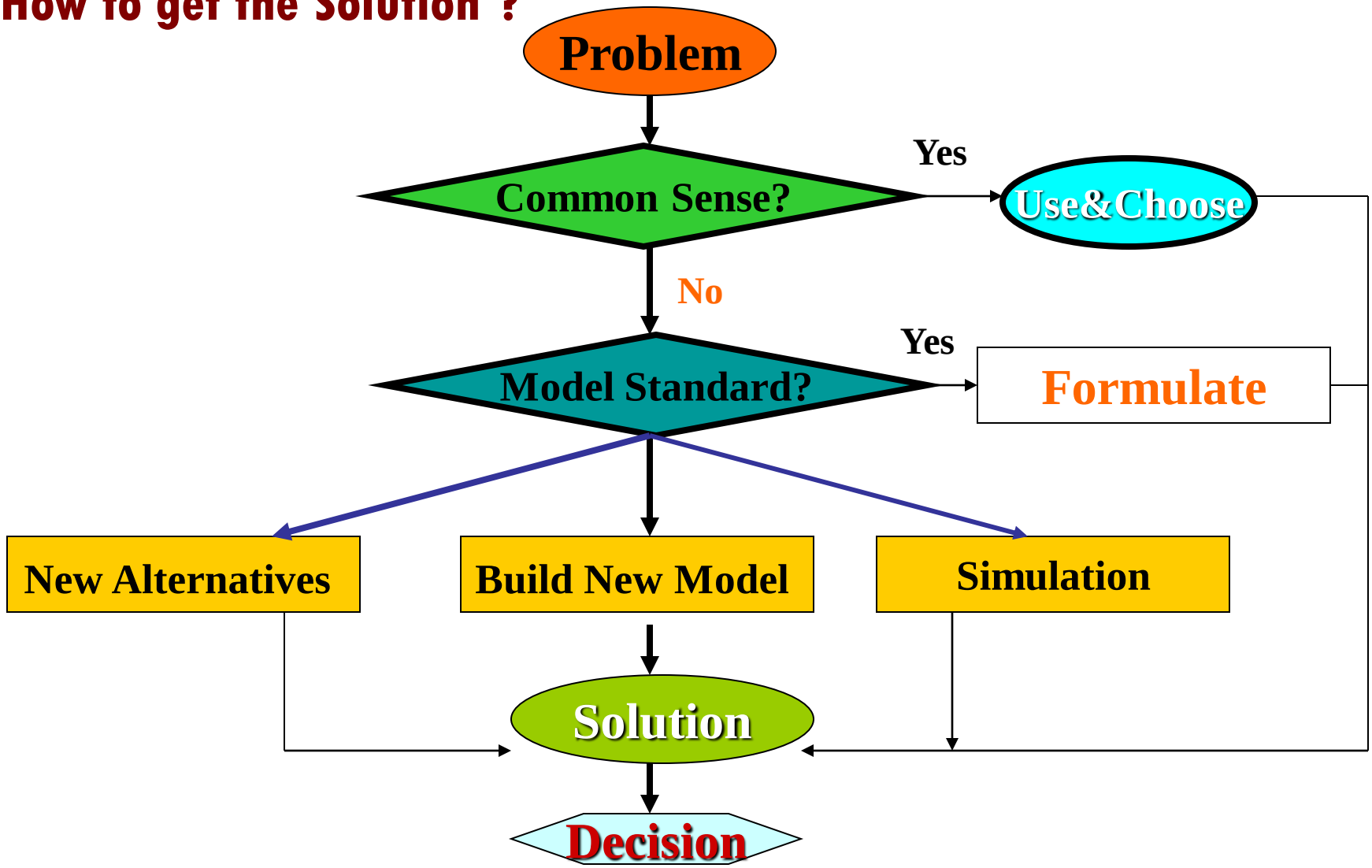
1. Problem Solving Approach

What **IE** Has To Do ?

1. Problem Identification
2. Generate Alternatives
3. Know the Standard Models
4. Decide Performance Criteria
5. Choose the Best Solution
6. Make Decision
7. Anticipate Managerial Implication
8. Action

1. Problem Solving Approach

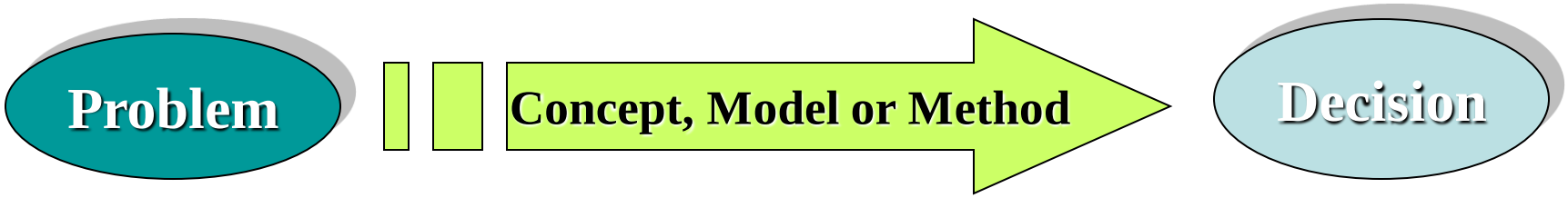
How to get the Solution ?



1. Problem Solving Approach

Research Flow Diagram:

- Research Flow Diagram reflects how the problem will be solved by the proposed concept, model or method



1. Problem Solving Approach

Steps in Problem Solving:

- Define Problem
- Generate Alternatives
- Choose Standard Model
- Get The Best Solution
- Make Decision
- Implementation/Action

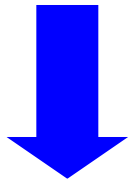
Problem Formulation:

Any unsatisfactory situation:

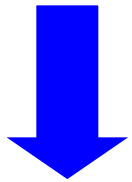
Symptom

Claims

Difference: Expectation vs Reality

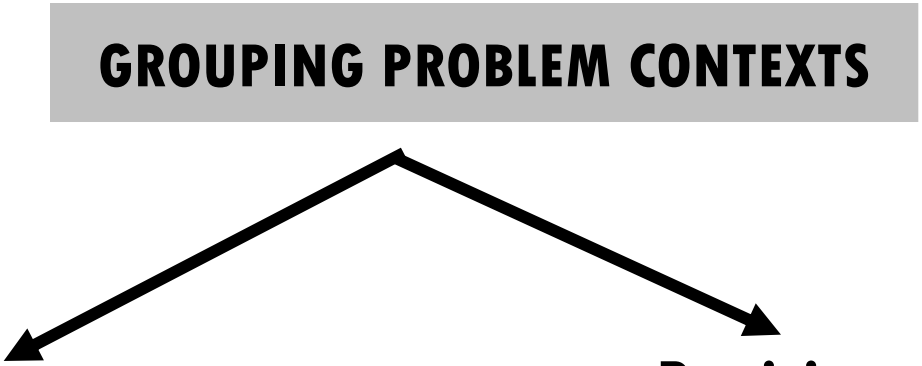


Root Causes



Problem

1. Problem Solving Approach

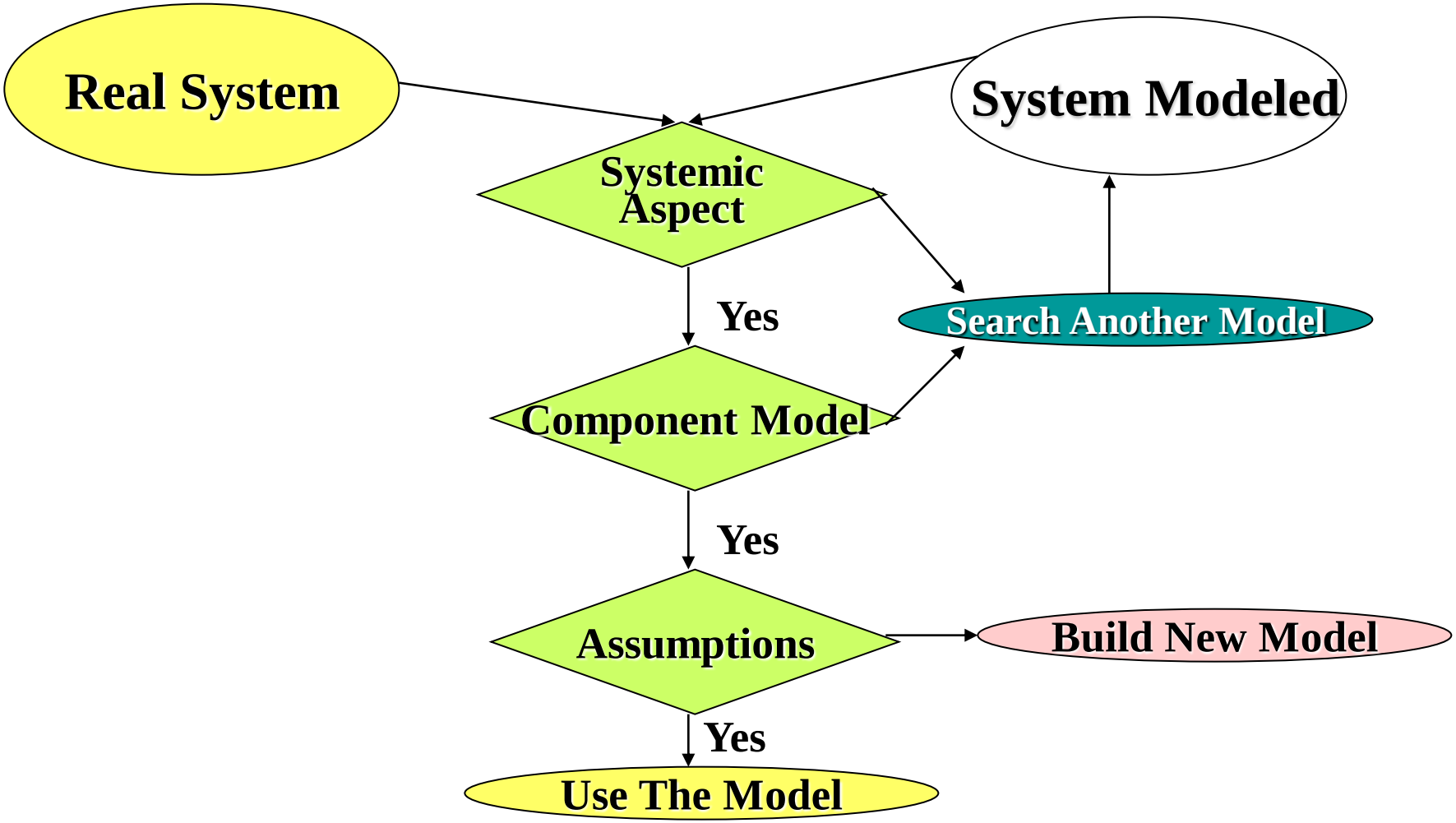


Problem Formulation:

- Preliminary Study
- List of Symptoms
- Identify Roots Causes
- Analysis
- Define Problem

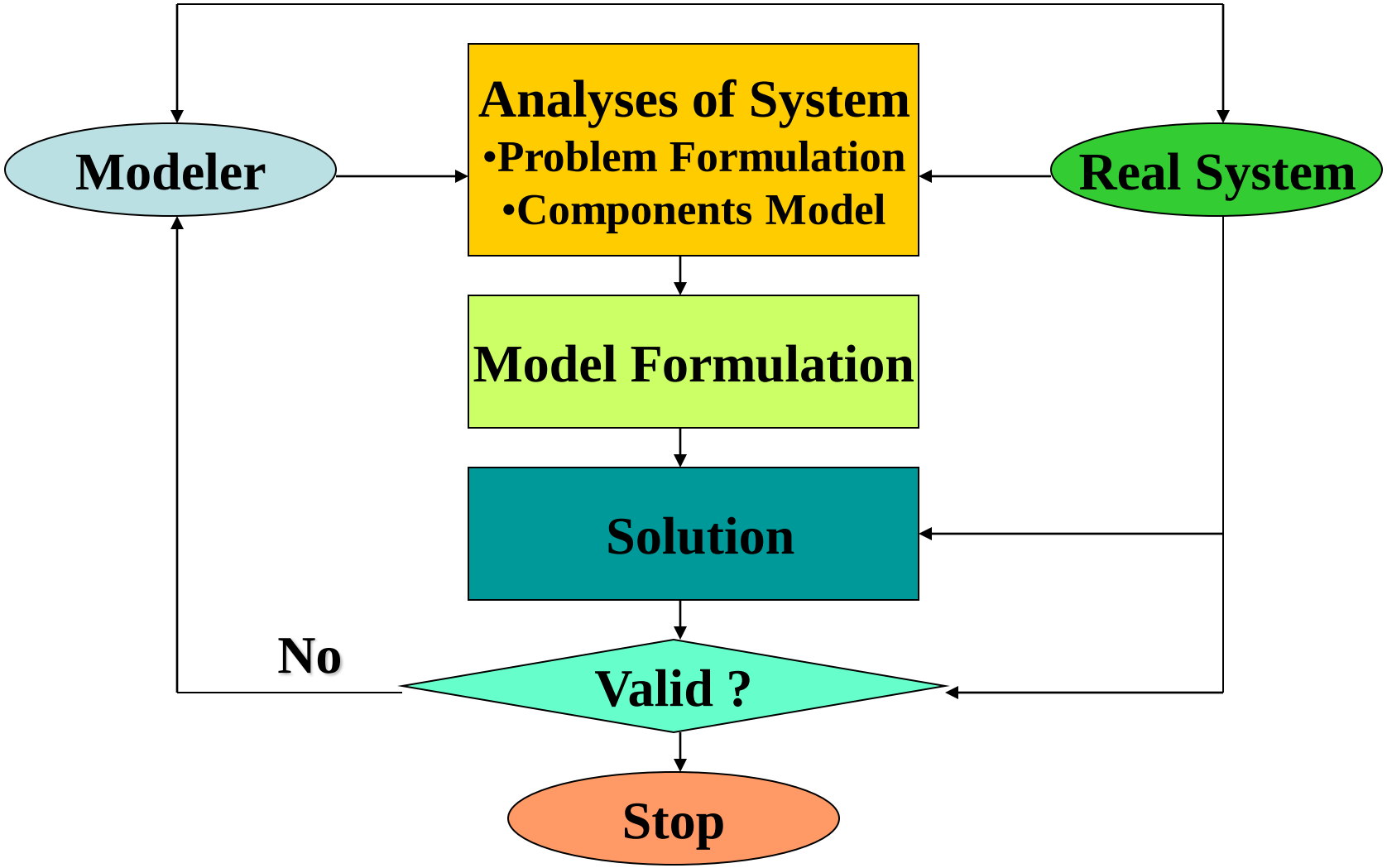
1. Problem Solving Approach

How to Choose The Model



1. Problem Solving Approach

Model Building Process:



1. Problem Solving Approach

Analysis of System:

- Formulate the Problem
- Determine Performance Criteria
- Identification of Components Model:
  - Decision Variable
  - Constraints
  - Parameter
  - Logical Relationship

Component Model:

- Performance Criteria
- Decision Variable
- Constraints
- Parameter
- Logical Relationship

Performance Criteria:

- Types: Single Criteria, Multi Criteria
- Level of Management: Company Level, Business Level, Operational Level

1. Problem Solving Approach

Model Formulation:

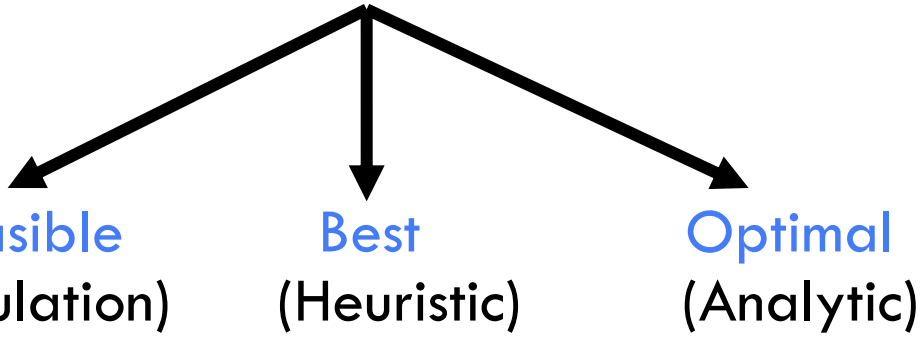
Determine the relationship among performance criteria, variables, parameters and constraints

Objective Function: $V = f (Xi, Yi, Ai)$

Constraints: $f (Xi, Yi, Ai) < Bi$

Solution:

- Value of Decision Variable
- Input For Decision Making

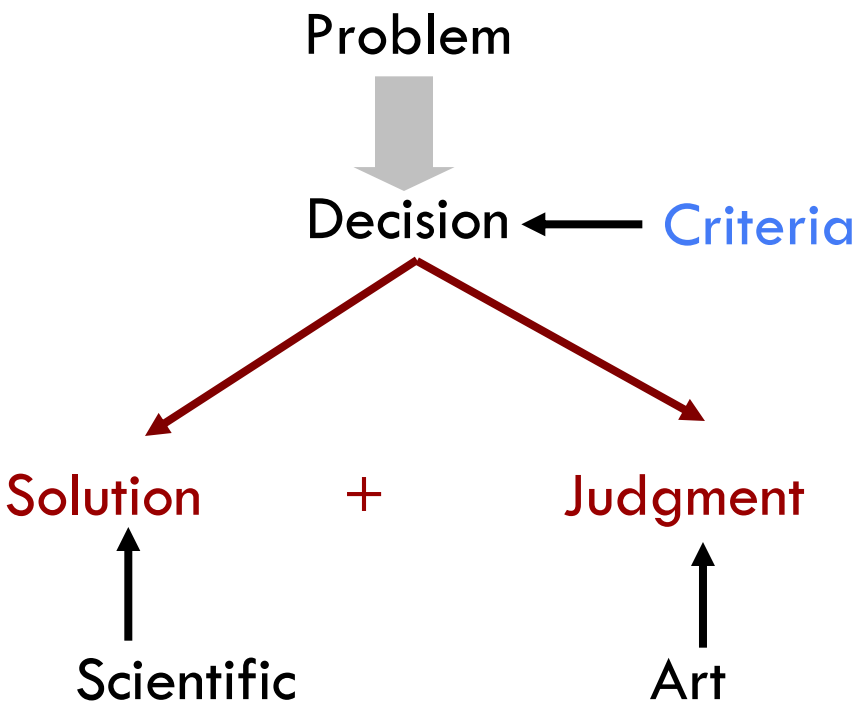


1. Problem Solving Approach

Validation:

- Logical Validation (Verification)
  - Is the Model logic and rational ?
- Historical Validation
  - Is the model fit with the past performance ?
- Result Validation
  - Is the model fit with the future performance ?

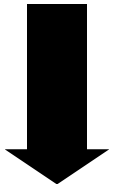
Decision:



1. Problem Solving Approach

Action:

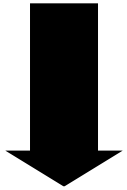
How decision could be implemented ?



Anticipate Managerial Implication

and

Prepare Implementation Plan



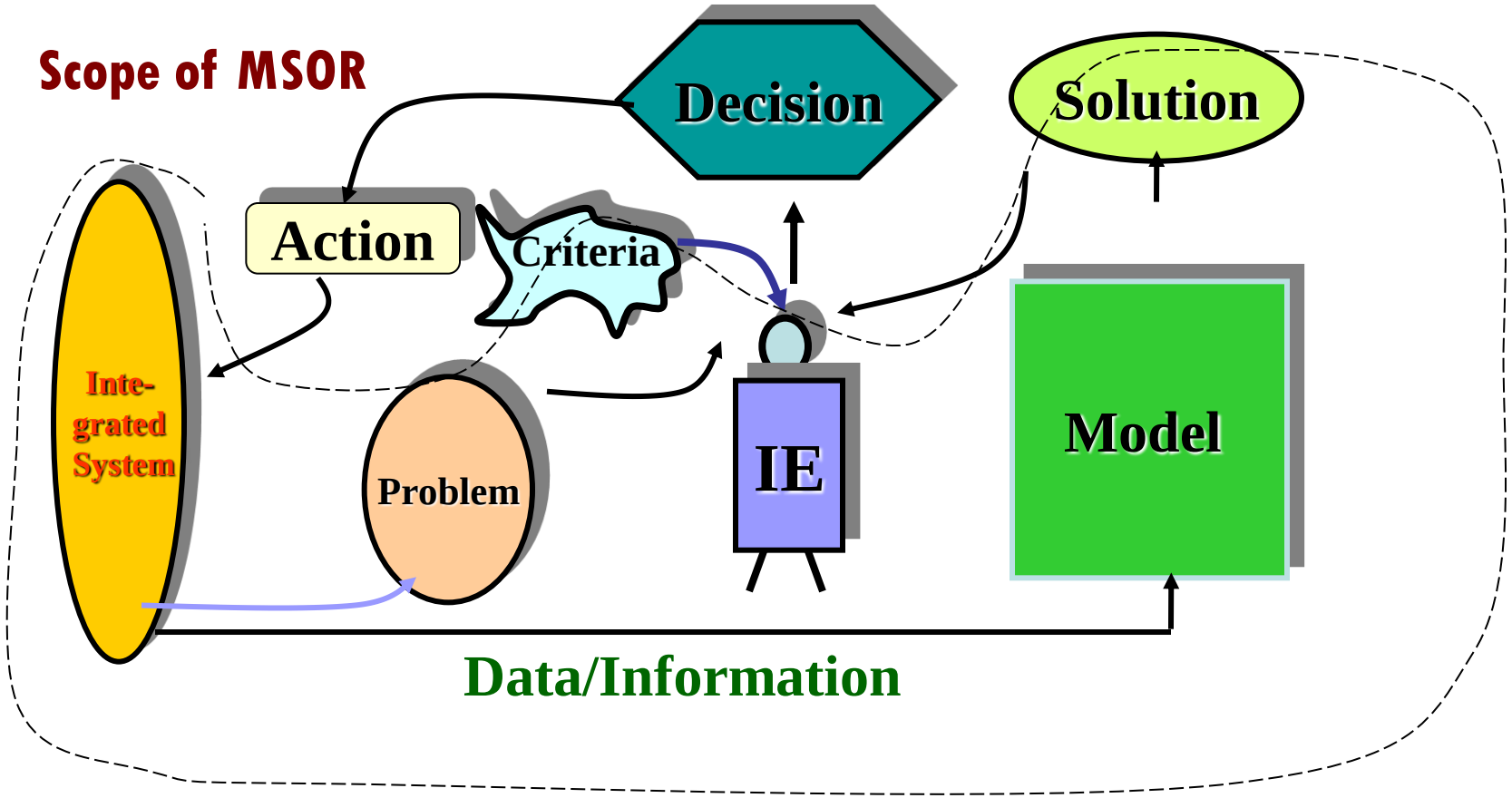
Action

Assumptions:

- Phenomena:
  - Static, Dynamic
- Measurement:
  - Discrete, Continue
- Population:
  - Deterministic, Probabilistic
  - Uncertainty
- Relationship:
  - Linear, Non Linear

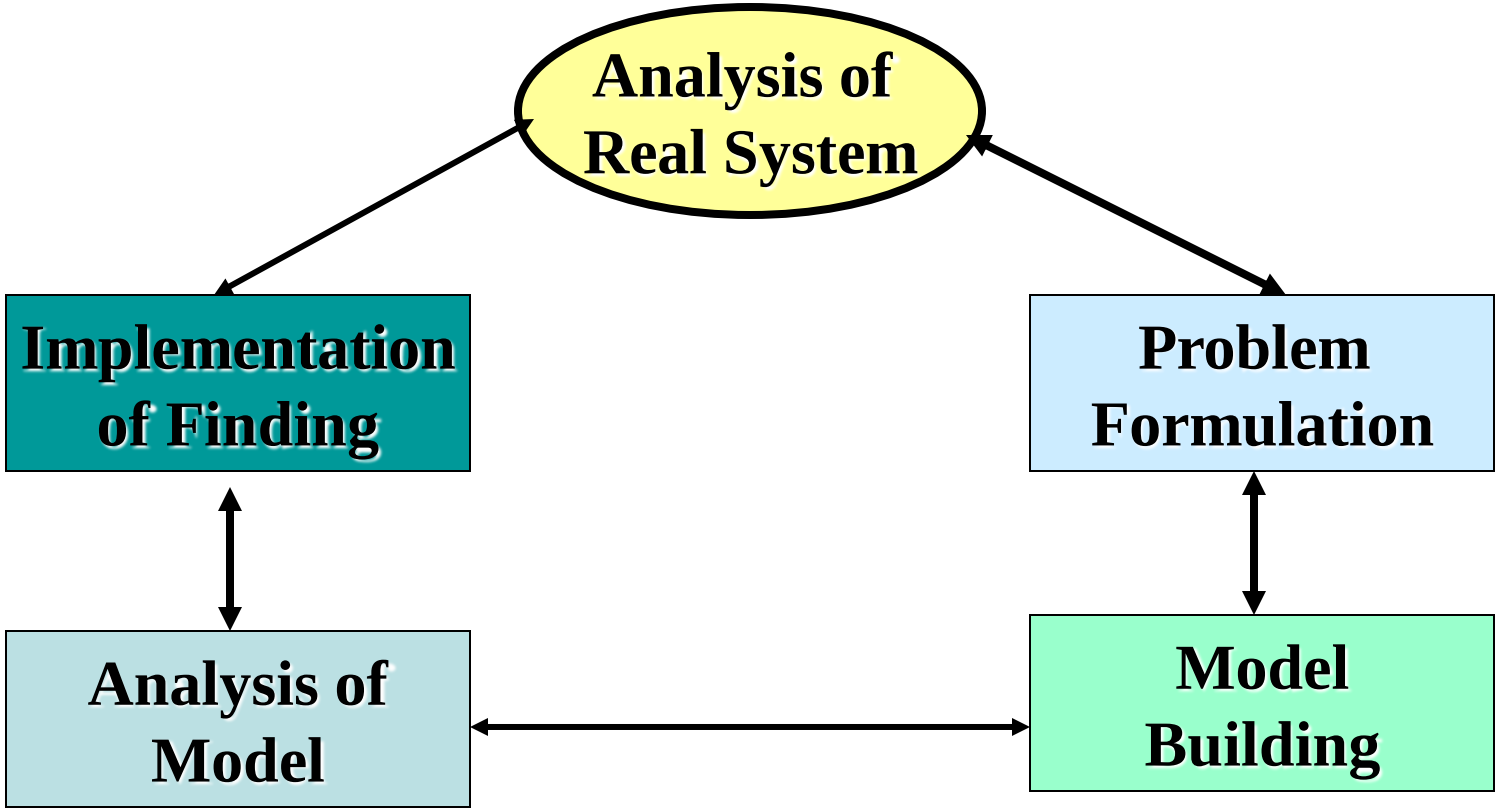
2. Management Science Approach

- Due to Limited Resources
- Using Mathematical & Statistical Approach to solve the real problem to obtained solution
- As a tool for Decision Making



2. Management Science Approach

- **Management Science Approach**



2. Management Science Approach

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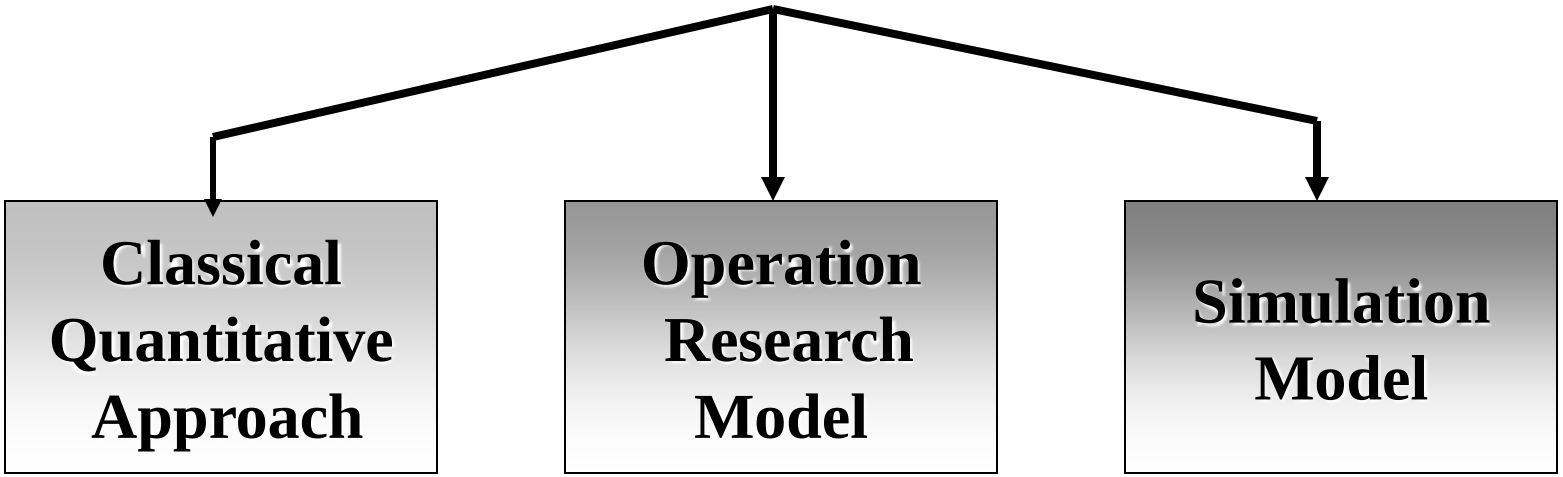
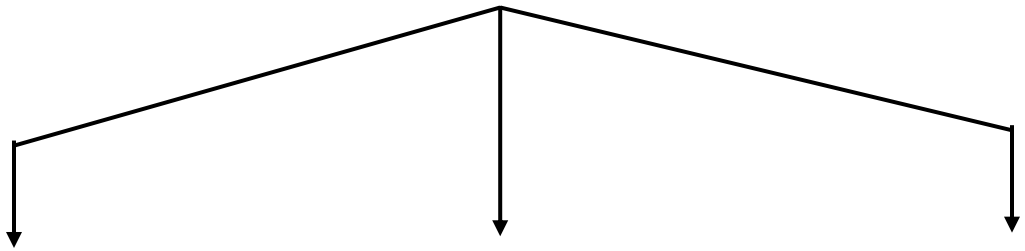


2. Management Science Approach

Classical Quantitative Approach

- Using classical Mathematical and Statistical Approach to solve the Quantitative Problem to obtained Optimal Solution Analytically
- Unconstraint problems

Taxonomi Problem



Pasti	Probabilistik	Tak Tentu
(Determitic)	(Probabilistic)	(Uncertainty)
S = 0	S ≠ 0	S ≠ 0
	Pola Diketahui	Pola Tak Diketahui

Catatan:

$$S = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}}$$

2. Management Science Approach

Wilson Formula:

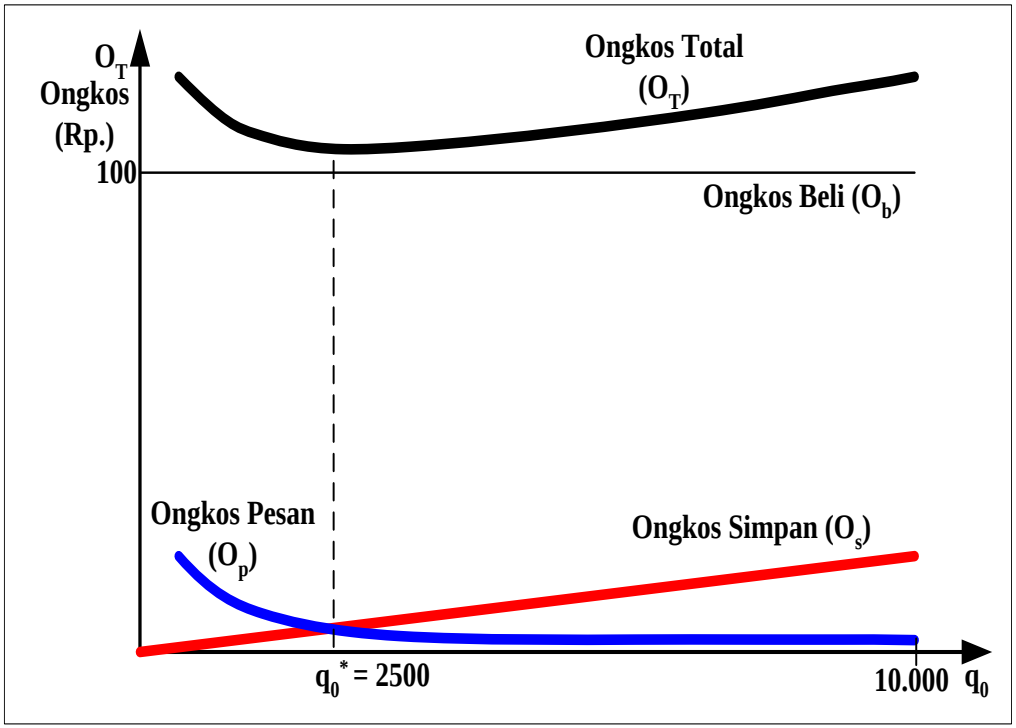
- The first mathematical approach used to solve the inventory problem
- Contoh Problem Inventory:
  - Diketahui:
    - D = 10.000 unit/tahun
    - A = Rp.1000.000,-/pesan
    - p = Rp. 10.000,-/unit
    - h = 20% dari harga/unit/tahun
  - Bagaimana kebijakan inventori optimal ?
  - Formulasi Problem : Bagaimana Menentukan Kebijakan Inventori Optimal?
    - Berapa Ukuran Lot Pemesanan Ekonomis ? (Economic Order Quantity: EOQ)
    - Kapan Saat Pemesanan Dilakukan (Re-Order Point: ROP)

2. Management Science Approach

Performance Criteria:

- Ongkos Inventori Total (Ot): $O_t = O_b + O_p + O_s$
  - Ot: Ongkos Inventori Total
  - Ob: Ongkos Beli
  - Op: Ongkos Pesan
  - Os: Ongkos Simpan

- Hubungan O_t dan Q_0



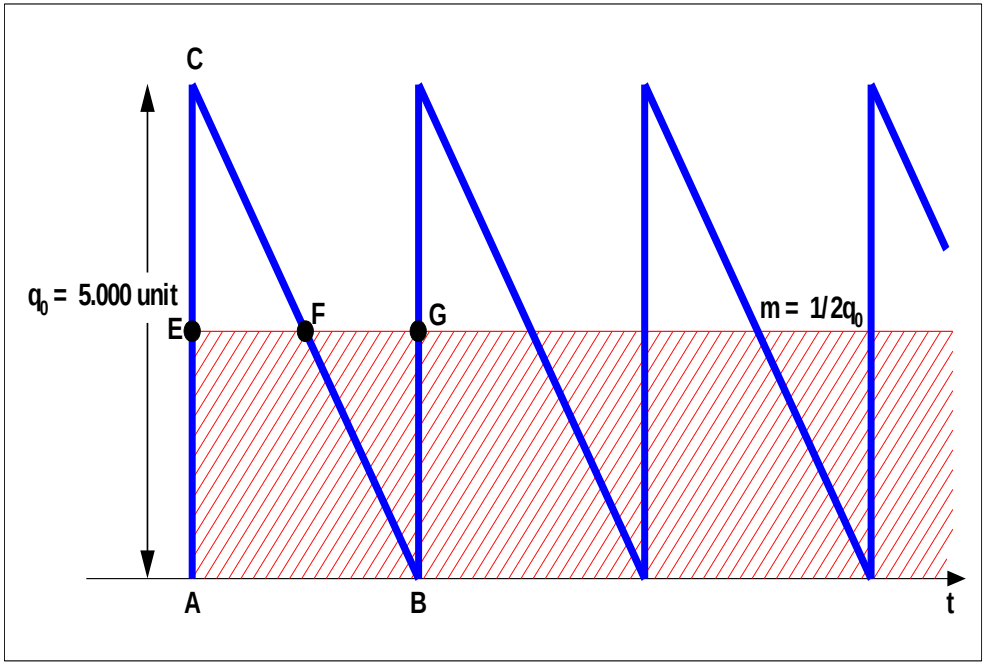
2. Management Science Approach

Asumsi Model Wilson:

1. Demand deterministik & barang datang secara uniform
2. Ukuran lot pemesanan tetap untuk setiap kali pemesanan
3. Barang yang dipesan akan datang secara serentak pada saat pemesanan
4. Harga barang konstan baik terhadap lot maupun waktu

Posisi Inventori:

- $S_{OP} = S_{OH} + S_{OO}$
  - S_{OP}: Posisi inventori (*stock on position*)
  - S_{OH}: Inventori tersedia (*stock on hand*)
  - S_{OO}: Inventori dalam pesanan (*stock on order*)



2. Management Science Approach

Formulasi Model:

- Min $O_t = O_b + O_p + O_s$
- dimana:
  - $O_b = D_p$
  - $O_p = AD/Q_o$
  - $O_s = hQ_o/2$

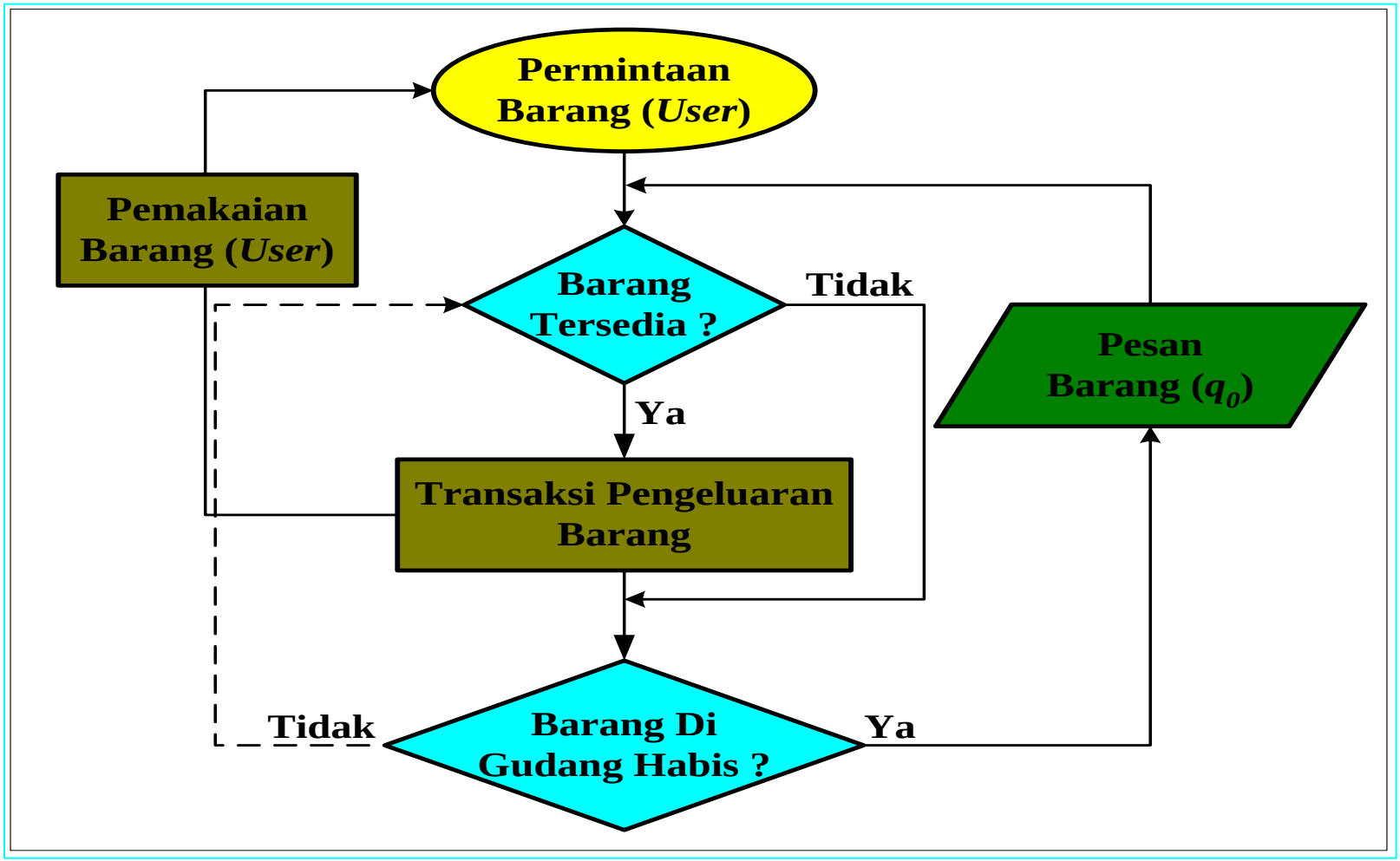
- Min $O_t = O_b + O_p + O_s$
  $= D_p + AD/Q_o + hQ_o/2$

Solusi Model:

- Syarat O_t minimal:
  - $\partial Ot/\partial Qo = 0$
  - $-AD/Qo^2 + h/2 = 0$
  - $Qo = \{2AD/h\}^{1/2}$

- **Solusi Optimal**
- $Qo = \{2AD/h\}^{1/2}$
- $= \{ 2.000000.10000/2000\}^{1/2}$
- $Qo = 3165$ unit

Mekanisme Model Wilson

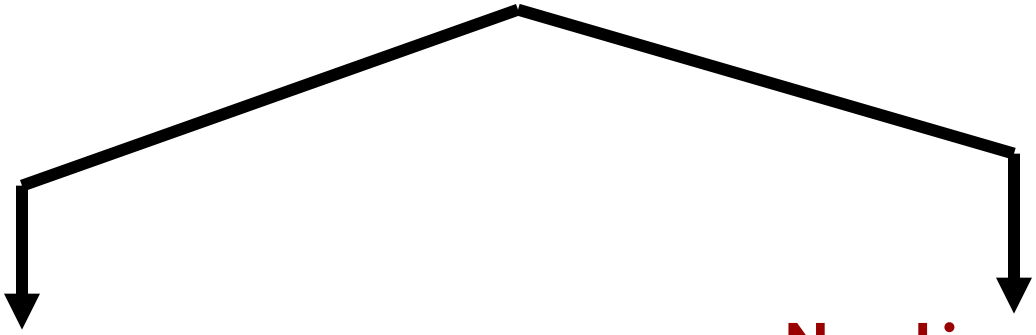


2. Management Science Approach

Operation Research Approach:

- Use Modeling Approach to solve the problem to obtained optimal solution
- Constraint problems

Operation Research Model:



Linear

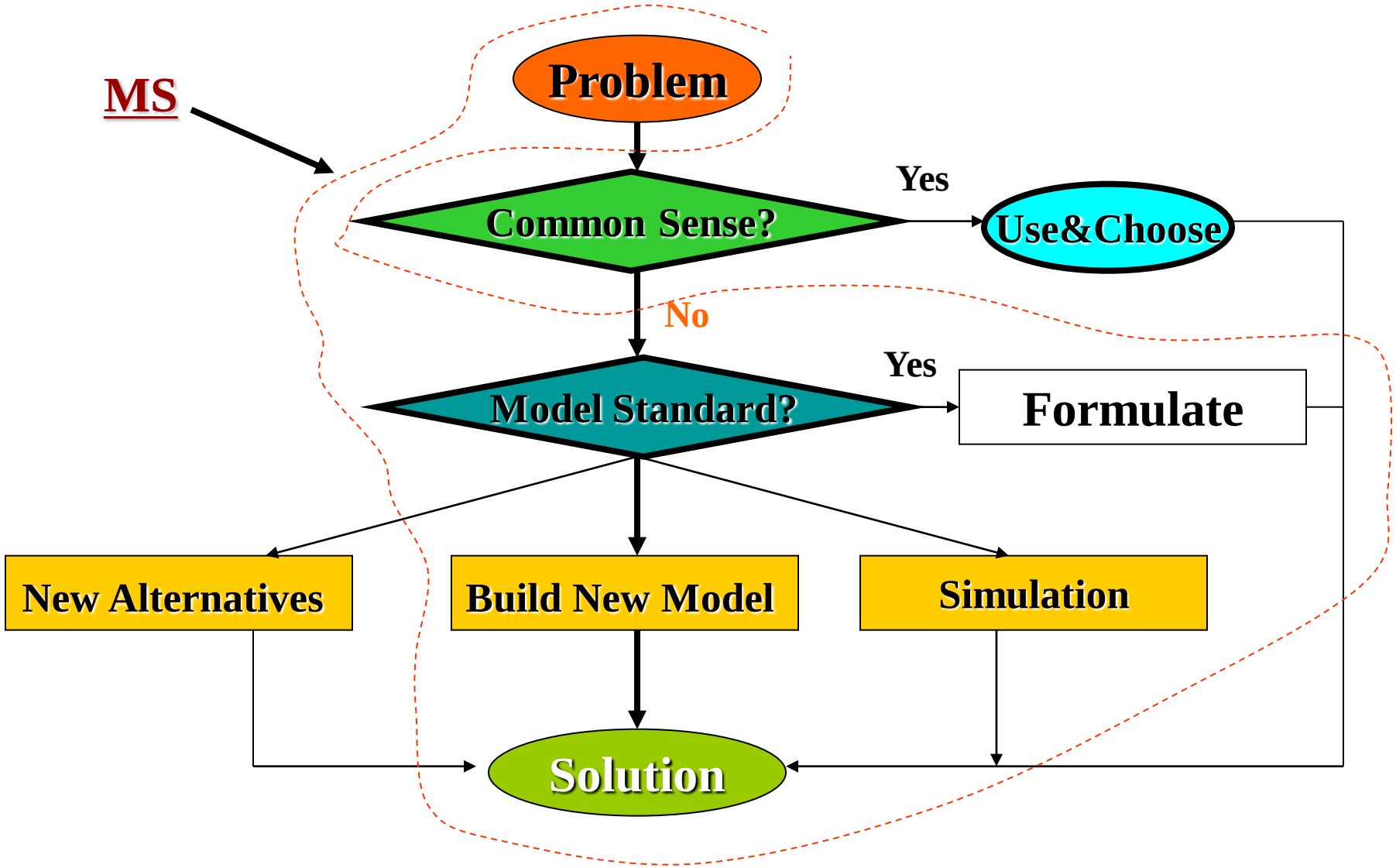
- Linear Programming
- Transportation
- Transhipment
- Network
- Etc.

Non Linear

- Queing
- Inventory
- Dynamics Prog.
- Stochastics Prog.
- Etc.

2. Management Science Approach

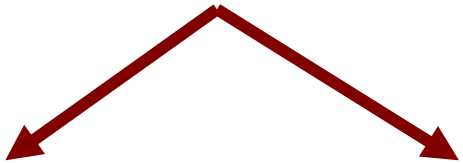
How to get the Solution ?



2. Management Science Approach

Model

Representation of system for special purposes



Representation	Purpose
Model Iconic	- Model Descriptive
Model Analog	- Model Predictive
Model Symbolic	- Model Normative

- Advantages Using Model:
  - Minimize Destructive Experiment
  - Minimize Complexity Of Real World
  - Minimize Negative Impacts
  - Minimize Cost
- Performance of Model:
  - Valid, Simple
  - Robust, Adaptive
  - Complete, Controlable
  - Communicable

2. Management Science Approach

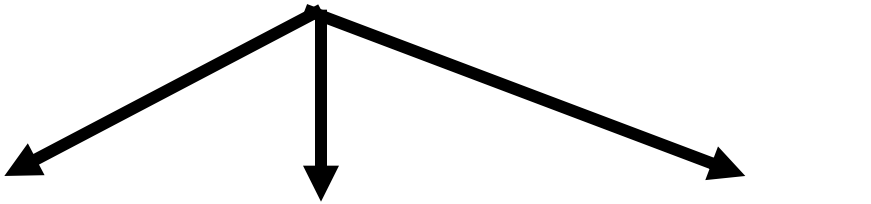
Model:

- Performance Criteria:
  - Types: Single Criteria, Multi Criteria
  - Level of Management: Company Level, Business Level, Operational Level
- Components Model:
  - Performance Criteria
  - Decision Variable
  - Constraints
  - Parameter
  - Logical Relationship

2. Management Science Approach

Solution:

- Solve the Problem
- Reflect Variable Decision
- Input For Making Decision



Feasible	Best	Optimal
(Simulasi)	(Heuristic)	(Analytic)

2. Management Science Approach

Model Formulation:

Determine the relationship among performance criteria, variables, parameters and constraints

Objective Function: $V = f (Xi, Yi, Ai)$

Constraints: $f (Xi, Yi, Ai) < Bi$

Linear Programming

- Asumsi:
  - Proprotionality
  - Additivity
  - Integrality

2. Management Science Approach

General Model:

Objective Function:

Min Z = c1X1 + c2X2 + c3X3 + c4X4 + ...+ cnXn

Subject to:

1. a11X1 + a12X2 +a13 X3 + a14X4 + ...+ a1nXn <= B1
2. a21X1 + a22X2 +a23 X3 + a24X4 + ...+ a2nXn <= B2
3. a31X1 + a32X2 +a33 X3 + a34X4 + ...+ a3nXn <= B3

. .

. .

m. am1X1 + am2X2 +am3 X3 + am4X4 + ...+ amnXn <= Bm

X1, X2, X3, X4 .....Xn >= 0

2. Management Science Approach

Contoh: Linier Programming

- PT XYZ produces sport jackets & slacks.
- The profit on each jacket is $ 10, and for pair of slacks is $ 15.
- Each jacket requires 2 m2 of material & 4 man-hours of sewing, which each pair of slacks requires 5 m2 of material & 2 man-hours of sewing.
- If there has 50 m2 of material & 36 man-hours of work available each week, how many jackets and pairs of slacks should be produced

2. Management Science Approach

Component of Model:

- Performance Criteria:
  - Profit/week ⟶ z
- Decision Variables:
  - Number of jackets produced/week ⟶ x1
  - Number of slack produced/week ⟶ x2
- Constraints:
  - Material: 50 m2/week
  - Sewing: 36 manhours/week
- Parameter:

	Jacket	Slack	
Profit	10	15	($/unit)
Usage of material	2	5	(m2/unit)
Sewing requirement	4	2	(manhour/unit)

- Logical Relationship: linier

2. Management Science Approach

Formulation of Model:

Objective function: V = f (Xi, Yi, Ai)

Constraints: f (Xi, Yi, Ai) < Bi

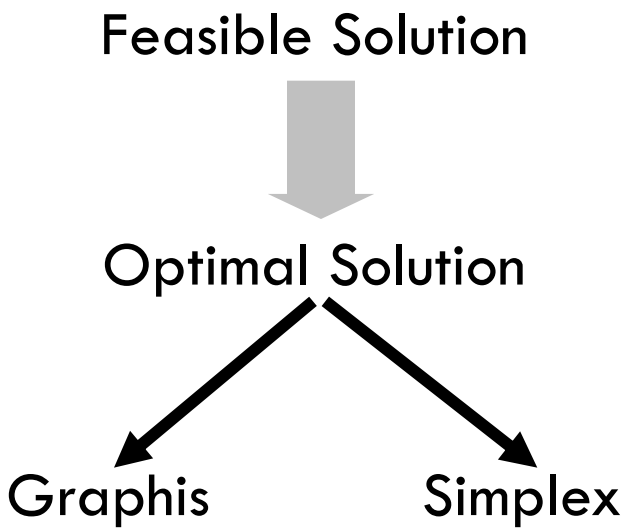
Objective function: Z = 10 x1 + 15 x2

Constraints:

- Material: 2 x1 + 5 x2 <= 50
- Sewing: 4 x1 + 2 x2 <= 36

x1 , x2 > = 0

Solution:

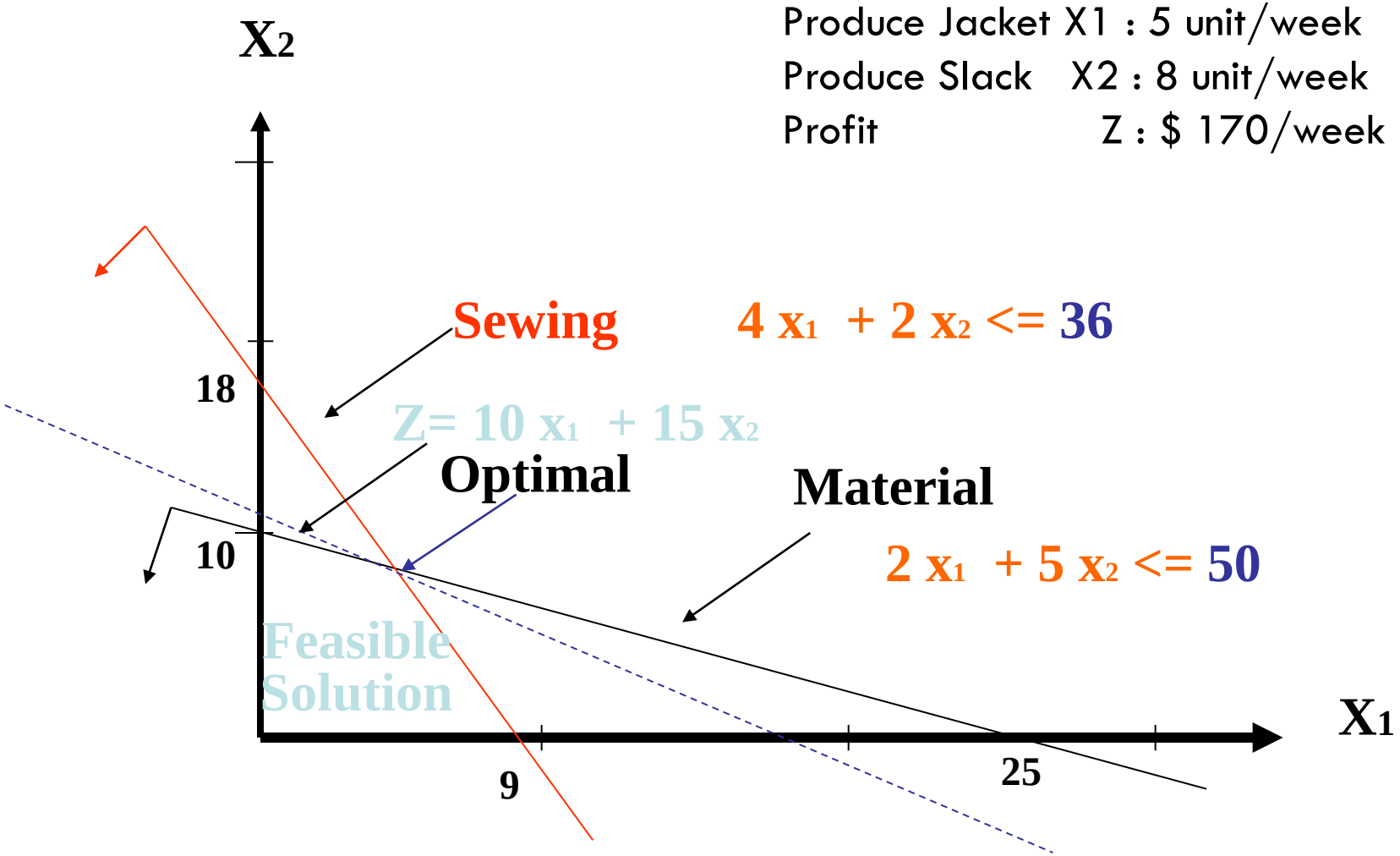


2. Management Science Approach

Graphical Method:

Optimal Solution:

Produce Jacket X1 : 5 unit/week
Produce Slack X2 : 8 unit/week
Profit Z : $ 170/week



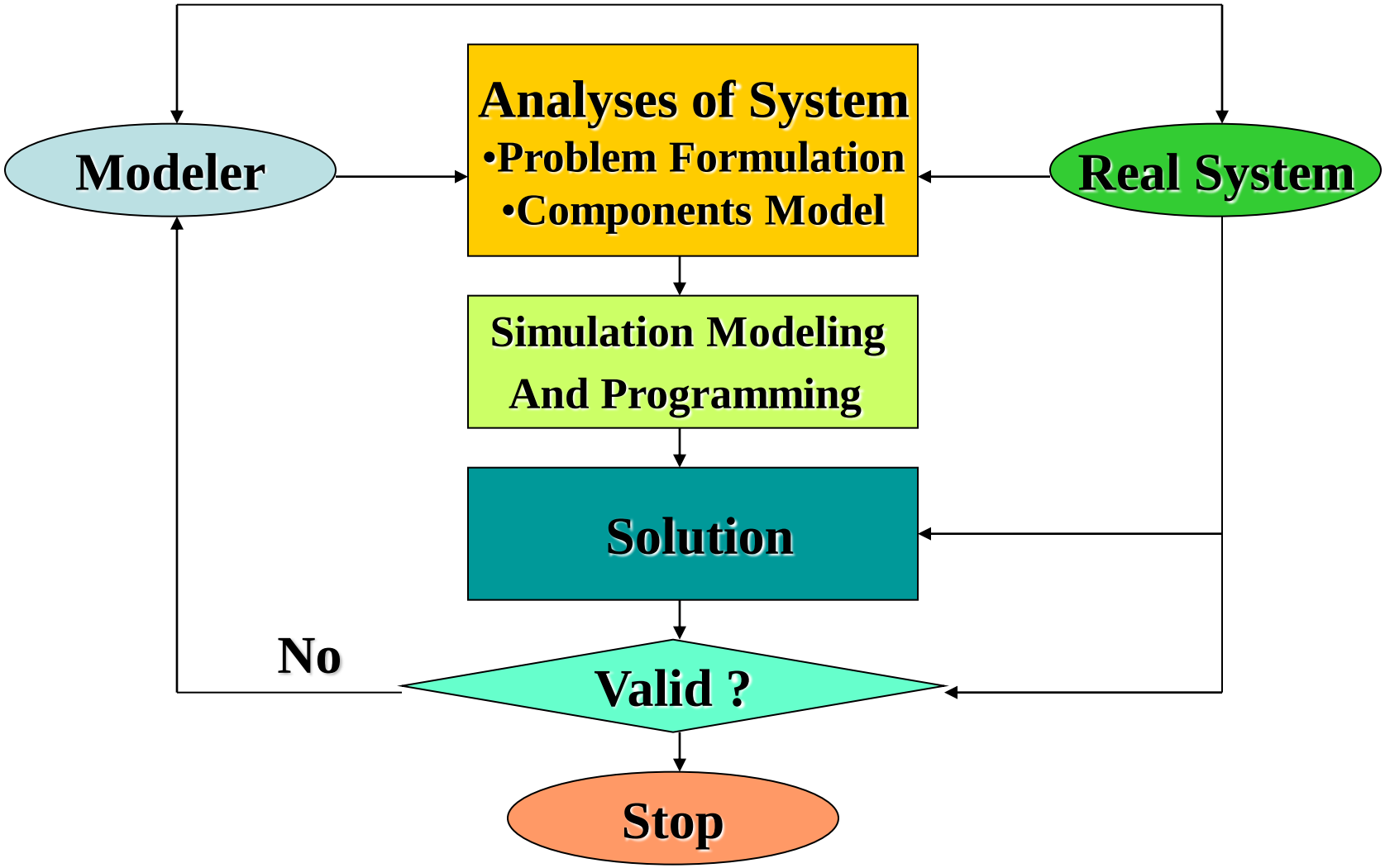
2. Management Science Approach

Simulation Approach:

- Use modeling approach to solve the problem to obtained feasible solution
- Non linear & uncertain phenomena
- Constraint problems
- What if analysis

2. Management Science Approach

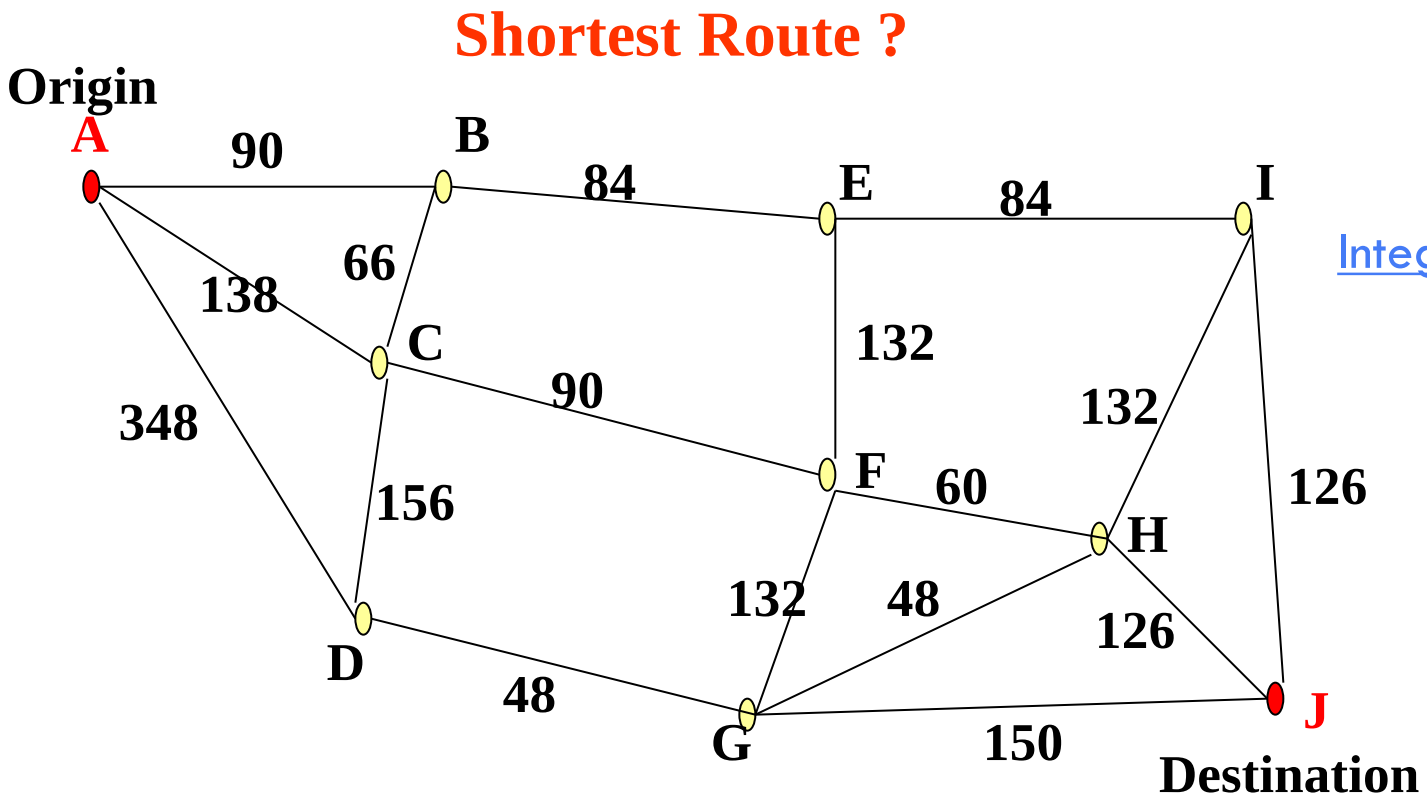
Simulation Process:



3. Integrated Approach

- Memandang sesuatu secara menyeluruh dan komprehensif tidak bersifat parsial

  ⇨ **Systemic Approach**



Solusi:

Parsial

Methoda: Logik ambil jarak terpendek pada setiap node

Hasil: A-B-C-F-H-G-J (494)

Integrated

Methoda: Dinamik programing

Hasil: A-B-E-I-J (384)

3. Integrated Approach

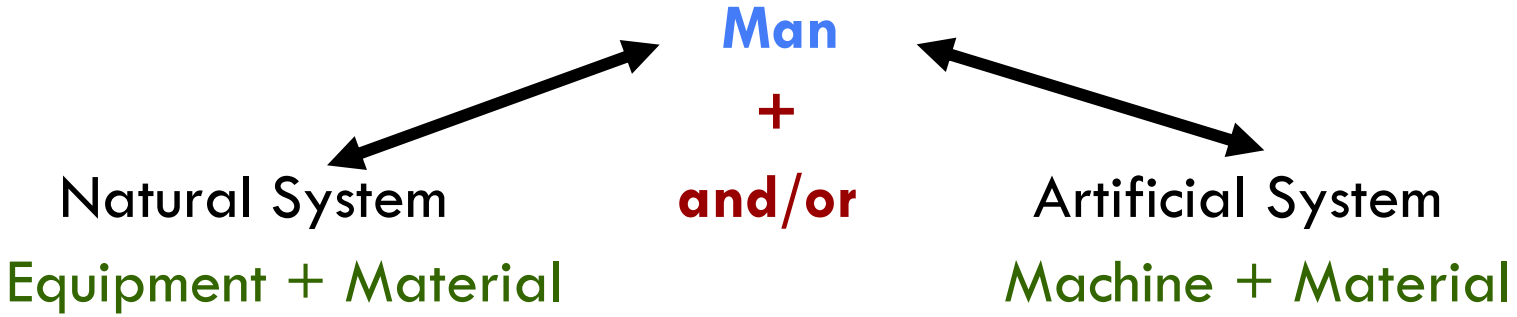
Systemic Aspect:

- Structural Aspect: Man, Machine, Material
- Functional Aspect: Man-Man, Man-Material, Man-Machine, Feed-back
- Boundary
- Environment: Stakeholder and Societal
- Objective: Unitary, pluralist, coercive

Characteristic of Integrated Approach:

- Problem: Real
- Model: Valid
- Solution: Feasible
- Decision: Effective
- Action: Implemented

Component of Real System:



3. Integrated Approach

Schematic Representation: