PEMODELAN SISTEM

Materi 4

System Characterization

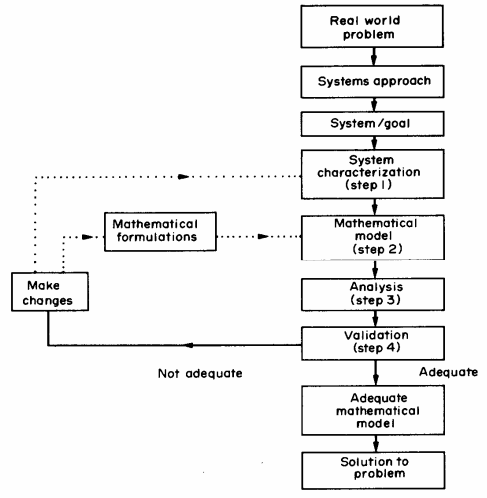


FIGURE 4.2 Mathematical modelling process (simplified).

System Characterization:
[Murthy et.al,1990]

- The SYSTEM APPROACH Offers a universal framework for treating such distinctly different problems
- In the systems approach the real world associated with the problem **is viewed as a system**
- The solution to the problem is viewed as a study of the system with a defined goals
- The starting point for such study is a proper description of the system.

System Characterization:
[Murthy et.al,1990]

- A total description -**unmanageable**
- **Not all features** of the real world are relevant to the problem or its solution
- A **partial description** is often adequate
- This partial description, called the **system characterization**, retains only features, that are relevant to the problem (Goal for study).

Basic Concepts

- System/Variable/Parameter
  - Variables are attribute needed to describe interaction between objects (components)
  - Parameters are attribute intrinsic to an object
- System/Environment
  - The interaction between the system and its environment is through variables common to both
- Relationships
  - The interaction between objects are described through relationships linking the variables of the interacting objects

Degree of Detail

- A Black Box description:
  - Described only by the variables through which it interacts with its environment, and the inner structure of the system is ignored (A Black Box description)
- A White Box description:
  - If one can describe all objects in the system and their attributes (through variables and relationships) -describing the system a greater detail (A White Box description)

Degree of Detail

- The degree of detail needed to describe a system appropriately depends on many factors
- If all the details are included - the description is unmanageable
- However, if significant details are omitted the description is incomplete
- One needs to find a sensible compromise (The art aspect of modelling process)

System Characterization

- Static vs Dynamic
  - static systems -time does not play any part
  - dynamic systems-time plays a very important role
- Continuous Time vs Discrete Time
  - In dynamic systems either some or all of the variable are changing with time -the change take place **continuously** with time or occur at **discrete instants** of time.

System Characterization

- Time Scale in Dynamic Systems
  - the variables change with time
  - The term 'time scale' is used to indicate the duration for significant changes to occur in a variable
- Deterministic vs Stochastic
  - If the values assumed by the variables are predictable with certainty (Deterministic systems)
  - If not, then uncertainty is a significant feature of the system -the changes in the variable are random and unpredictable (Stochastic systems)

Keputusan Pembelian Terigu

- Pabrik roti membeli terigu dengan harga $1000 per ton. Kebutuhan terigu relatif konstan selama setahun dengan total permintaan per bulan sebesar 20 ton. Terigu dikirim dari pabrik terigu dengan menggunakan truk dan ongkos per sekali kirim $132, tidak tergantung dari jumlah terigu yang diangkut.
- Uang yang digunakan untuk membeli terigu berasal dari suatu investasi dengan interest sebesar 8% per tahun. Juga, terigu yang disimpan diasuransikan dengan premi 16% yang dihitung berdasarkan nilai rata-rata persediaan per tahun. **Manajer pembelian** ingin mendapatkan kebijakan pembelian terigu yg lebih baik dari yang terjadi sekarang.

System Description

System

Observer: *Purchasing Manager*

Purpose: *Improve flour purchasing policies –cost/profit*

Environment: *Bakery, flour wholesaler,orders, …*

Inputs: Controllable: *How much flour to buy and when.*
Uncontrollable: *Flour requirements, costs, …*

Outputs: *Total annual cost*

Components: *Average inventory, annual transport cost, …*

Relationships: *How costs are incurred, …*

Mathematical Model

Economic Order Quantity (EOQ) model

To meet demand on time, a firm stock-piles product.

They must decide when to replenish the stock-pile and how much product to order, to balance the demand against ordering costs, holding costs, and the value of stock on hand.

Assumptions

1. Demand is deterministic and occurs at a constant rate.
2. An order incurs a fixed cost, irrespective of the order size.
3. No shortages are allowed.
4. There is no lead time on re-orders. *Instant*
5. The holding cost is constant per $ of product per year.

Mathematical Model

Uncontrollable Inputs/Data

Annual requirement/demand: *D units/year*

Value of product per unit: *v $/unit*

Fixed order cost (per order): *s $/order*

Holding cost as a penalty per "held" $ per year: *r /year*

Controllable Input/Decision variable

Order quantity: *Q units/order*

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Mathematical Model

- Replenishment should only occur when the stock-pile is *empty.*
- The order quantity for all replenishments should be the same.
- Given a fixed order quantity, Q, the average number of orders per year is *D/Q.*
- Given a fixed order quantity, Q, the average cost per year is:
  $Cost(Q)$ = order-cost + holding-cost = $sD/Q + \frac{1}{2}Qvr$
- The optimal (economic) order quantity is $EOQ = \sqrt{\frac{2sD}{vr}}$

  This minimises the cost, Cost(Q).

Alan Sartori

EOQ Model

Fitting to an EOQ model

Annual requirement: D = *20 tonnes/month × 12 months/year*
= 240 tonnes/year

Value of product: v = *$1000/tonne*

Fixed order cost: s = *$132/order*

Holding cost penalty: r = *0.08/year + 0.16/year*
= 0.24/year

Total cost by order quantity

$$Cost(Q) = \frac{sD}{Q} + \tfrac{1}{2}Qvr$$
$$= \frac{132\times 240}{Q} + 0.5\times 1000\times 0.24\times Q$$
$$= \frac{31680}{Q} + 120Q$$

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Solution

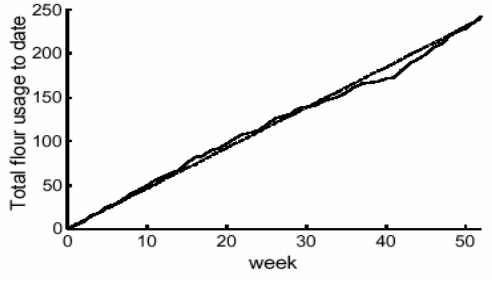
Optimal order quantity

$$EOQ = \sqrt{\frac{2sD}{vr}}$$
$$= \sqrt{\frac{2\times 132\times 240}{1000\times 0.24}}$$
$$= 16.25 \text{ tonnes}$$
$$Cost(EOQ) = \frac{31680}{16.25} + 120\times 16.25$$
$$= \$3900$$

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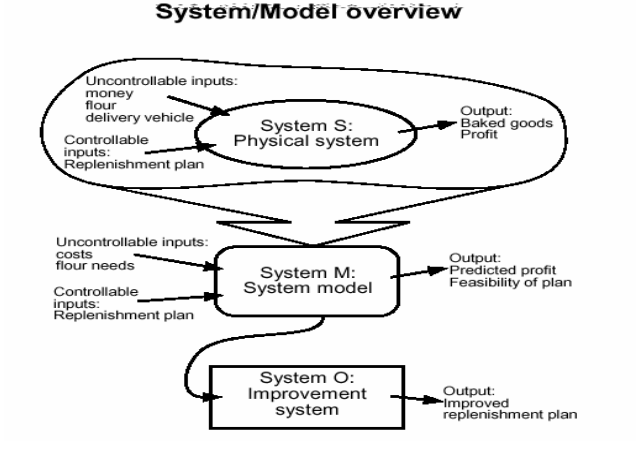
Validation:[Internal]

1. Demand is deterministic and occurs at a constant rate.
   Test by graph: *Reasonable*



Validation:[Internal]

2. An order incurs a fixed cost, irrespective of the order size.
   – Delivery cost. *Reasonable*
3. No shortages are allowed. *True/ might be some flexibility*
4. There is no lead time on re-orders. *Not true*
   – This, with the optimal policy, might *create a shortage. Impose a buffer—how big?*
5. The holding cost is constant per $ of product per year.
   – Assumes the interest rate is constant. *Reasonable*
   – Assumes that the insurance premium is based on the current average inventory. *Reasonable*



System/Model Overview

System M is a mathematical model of System S

It can be used to test various replenishment plans and the effects of changes in uncontrollable inputs too.

System O has System M as the input and it produces an improved solution