Application of Artificial Intelligence for Agrifood SCM Design

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Agrifood and Agroindustrial SCM

- Agrifood SCM
- Agroindustrial SCM
  - Not only food
  - Also other agroindustrial produces and products

Agroindustrial Supply Chain Management

- Agroindustrial Supply Chain Management (Agro-SCM) :
  The management of the entire set of
  - production,
  - transformation/processing,
  - distribution and marketing activities

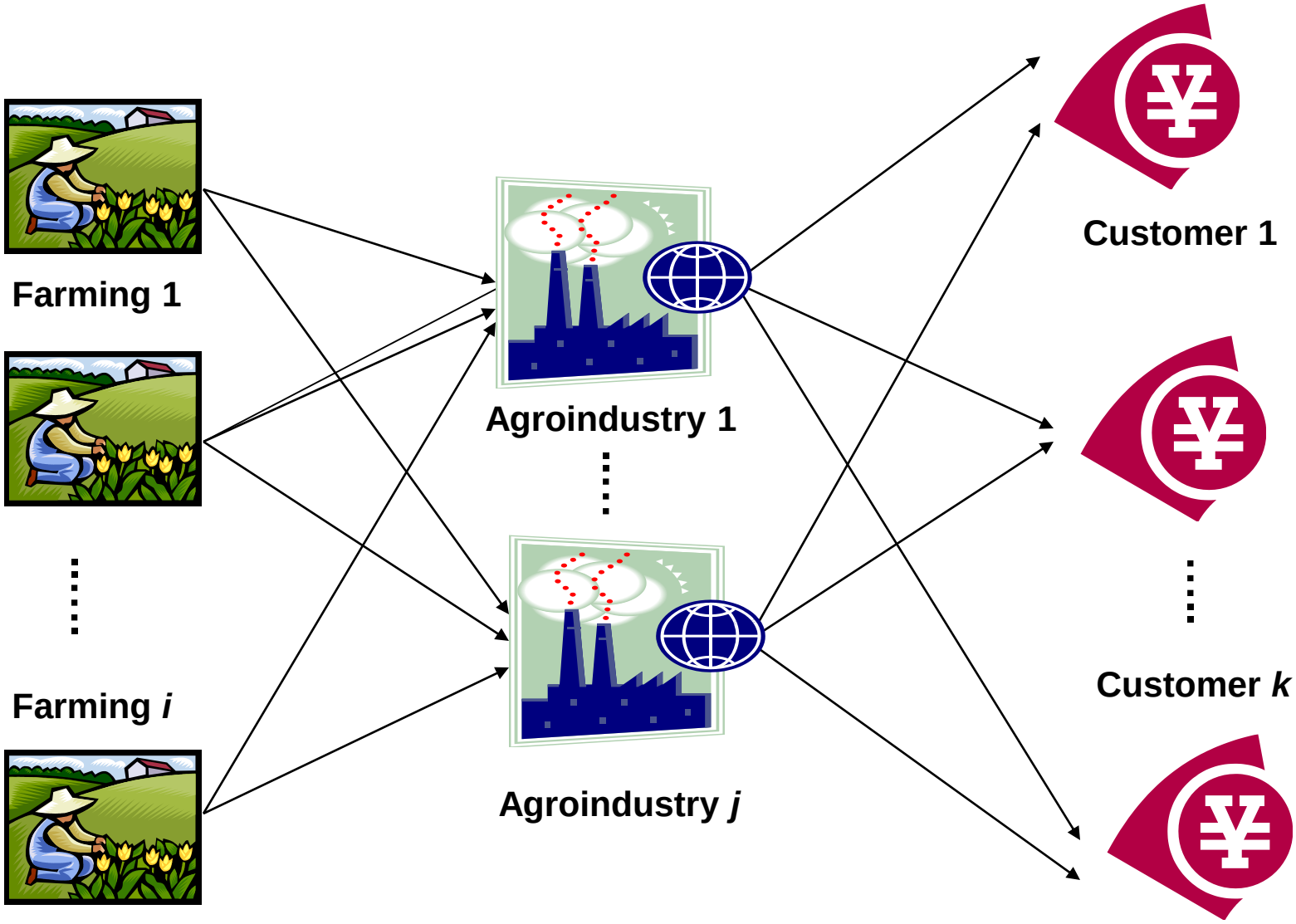
  in agroindustry by which a consumer is supplied with a desired product
- Agro-SCM is more complicated than manufacturing SCM
  → agricultural products are perishable

- Management:
  - Design
  - Optimization

- Objectives:
  - Cost, Quality, Time (Delivery)
  - Flexibility
  - Sustainability
  - Halalness

- Variables:
  - Materials (Supply)
  - Information (Demand)
  - Cash

Description of Agro-SCM Model

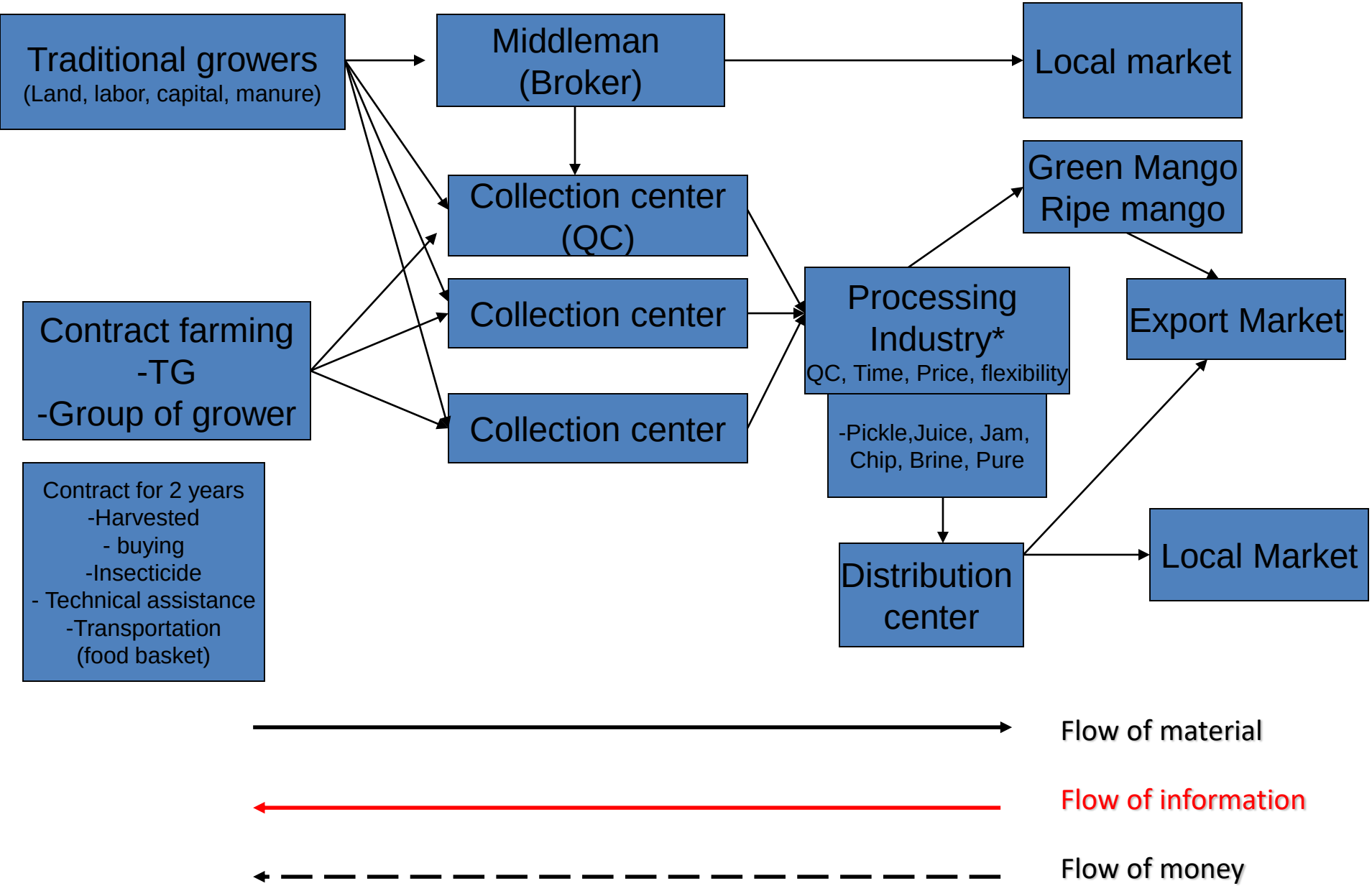


Objectives

- First Objective:
  - Minimizing Total Supply Chain Cost (TSCC) that consists of transportation and inventory costs
- Second Objective :
  - Minimizing Expected Number of Deteriorated Product (ENDP) → *Maximizing quality*
  - Very essential for agroindustry
- Third Objective:
  - Risk
- As the three objectives are conflicting :
  - No single optimum solution
  - Pareto-optimum or non-dominated solutions or trade-off solutions
  - Needs advanced techniques such as Artificial Intelligence

- The supply chain for an agroindustry can be very complicated because:
  - Many agroindustries have hundreds, if not thousands, of suppliers
  - Needs many distribution centers and transportation services
  - Flow of materials is very complex due to unpredictable demands and dynamic performance of numerous suppliers
  - Customer-supplier relationship is unique for each type of agroindustry

An Example of Agro-SCM → Mango


Traditional growers
(Land, labor, capital, manure)
Middleman
(Broker)
Local market
Collection center
(QC)
Green Mango
Ripe mango
Collection center
Processing
Industry*
QC, Time, Price, flexibility
Export Market
Contract farming
-TG
-Group of grower
Collection center
-Pickle,Juice, Jam,
Chip, Brine, Pure
Contract for 2 years
-Harvested
- buying
-Insecticide
- Technical assistance
-Transportation
(food basket)
Distribution
center
Local Market
Flow of material
Flow of information
Flow of money

Components	Current and emerging issues		
	Technology Process, People (manpower)	Decisions	Information
Farmers	Plantation/cultivation Grower Post harvest	Quantity Quality (size, ripeness) Cost	Growing time Weather demand
Contract farmers	Technical Assistance Pest control	Delivery time Quantity Quality, Cost	Pricing Transportation Procurement
Collectors	Contract with farmers Efficient Collection center Delivery schedule	Target Price Quantity	Demand, QC, transportation
Processors	Food processing technology QC, HACCP,	Quantity Quality (color, taste) Cost Exchange information Institutional View	Demand Quality of raw material Process capability
Distributors	Distribution system (planning, transport, equipment, bar code…	- Location and quantity to be distributed - Most efficient network	Demand Price
Exporters	Export regulation GPS facilities Export facilities Banking facilities	Target	Demand Price Quality Innovative

Events or Issues :

- Demand side:
  - Demand of fresh mango from Japanese Market
  - Quality, Cost, Timeliness and Flexibility
- Supply side:
  - Farmer and grower
  - Quantity, Quality, Sustainability, Profitability
- SCM model:
  - Non-collaborative SCM
  - Collaborative SCM
  - Integrative SCM (vertical integration)

Flow of materials vs. flow of money :

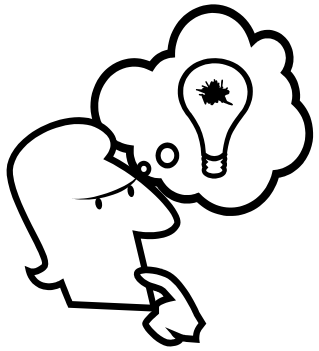
- Materials some from farmer to broker, agroindustry and so on
- However, in fact, the highest margin is received by exporters or distributors (up stream parties) not the farmers or agroindustry
- This profit distribution must be improved in the future for the sake of poverty alleviation, economic development of a nation as well as building more efficient and responsive supply chain

Agrifood SCM Design

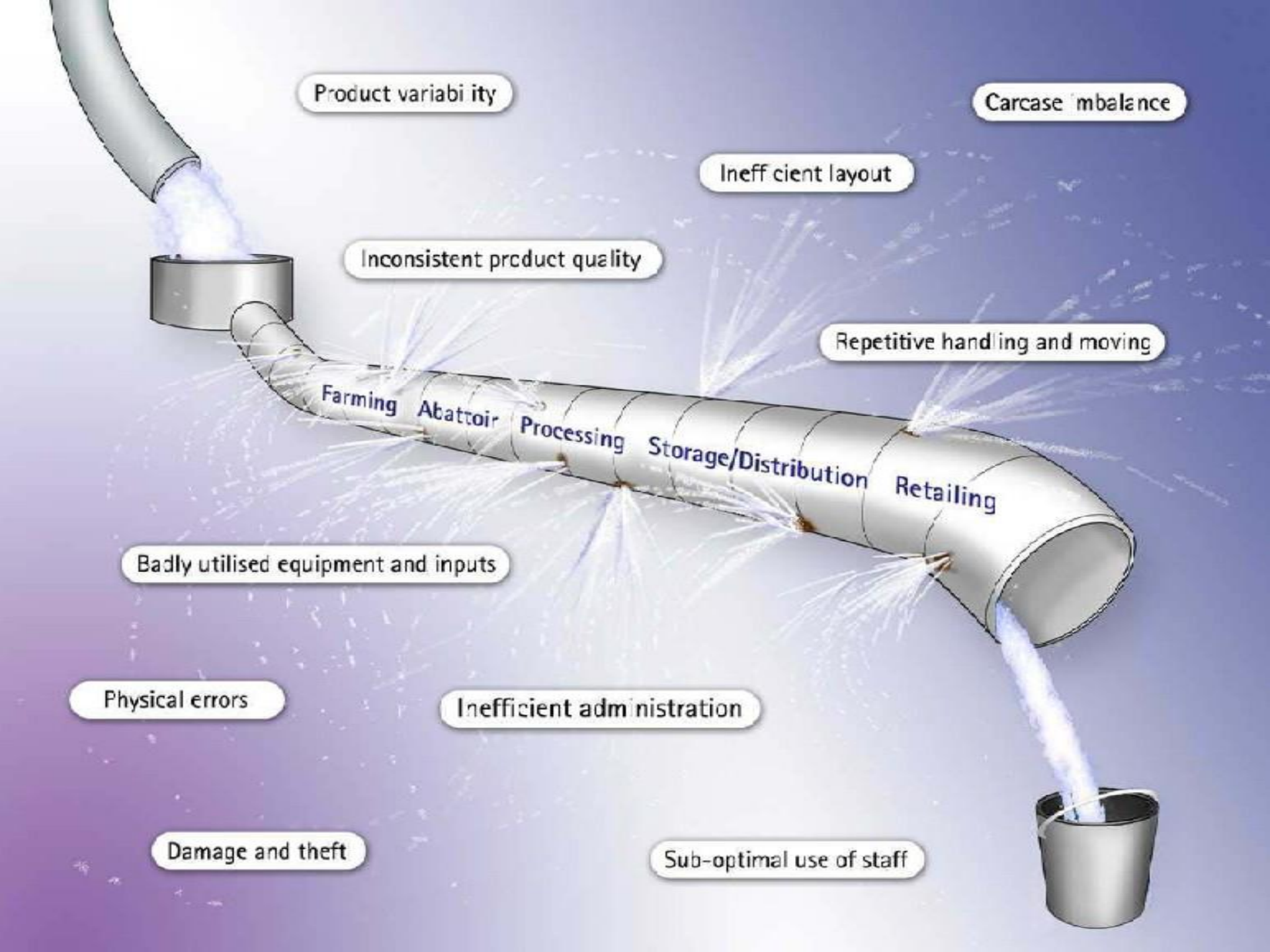
- Tujuan: Untuk merancang (design) Agrifood SCM agar lebih kompetitif di pasar domestik dan global
- Design (untuk bisnis baru)
- Re-design (untuk memperbaiki bisnis yang sedang berjalan)
- Metoda:
  - Pendekatan Sistem (System Design)
  - Kuantitatif (Mathematical Modeling) dan Kualitatif
  - Berbasis Ilmu dan Teknologi Komputer Maju (Advanced Computing Technology)
  - Artificial Intellegence

- Model proses bisnis sudah berubah dari bentuk lama (bisnis tunggal) ke bentuk baru berupa rantai pasok atau SCM (terdiri dari beberapa komponen bisnis)
- Jaringan SCM meliputi : Supplier, Industri, Distributor
- Fokus topik ini:
  - Disain dan Optimasi SCM
  - Menggunakan Model dan Teknik Baru
    - Algoritma Genetika (Genetic Algorithms) → 2 buku
    - Teknik-teknik Artificial Intellegence lainnya (Expert System, Fuzzy Logic, Neural Networks, dll)

Mengapa SCM harus dirancang dengan baik?

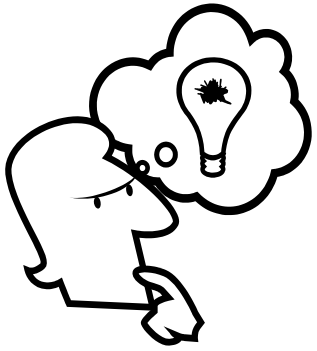


Bagaimana caranya?


Product variabi ity
Carcase mbalance
Ineff cient layout
Inconsistent product quality
Repetitive handling and moving
Farming
Abattoir
Processing
Storage/Distribution
Retailing
Badly utilised equipment and inputs
Physical errors
Inefficient administration
Damage and theft
Sub-optimal use of staff

Goals of SCM:

- Lowered operating cost
- Decreased procurement cost
- Reducing marketing cost
- Lowered distribution cost

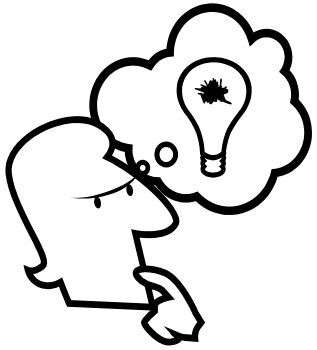


Bagaimana Caranya ?

Contoh:

Komponen Biaya	Agroindustri A	Agroindustri B	Teknik/Strategi
Pembelian bahan baku	10	8	Buyer-Supplier Relationship
Pengiriman bahan baku	15	14	Networks Optimization
Pembuatan produk • Proses • Inventory • Dll	30	25	Lean System/JIT/TPS
Pengiriman produk ke distributor dan konsumen • Inventory • Dll	17	15	Networks Optimization
• Total	72	62	SCM Design and Optimization

Cost Only ?



Integrated Goals:

- Cost
- Quality
- Delivery Time
- Flexibility
- Sustainability
  - Environment
  - Social
  - Economic

Multi-objective Decision Making !

Decision Points:

- Supply chain strategy or design
- Supply chain planning
- Supply chain operation

Strategi Perancangan dan Optimasi

- Parsial
  - Satu aspek saja yang dirancang/dioptimumkan
- Sekuensial
  - Beberapa aspek dirancang/dioptimumkan secara berurutan
- Simultanenous
  - Beberapa aspek dirancang/dioptimumkan sekaligus atau secara bersamaan

QUANTITATIVE METHODS

WHY QUANTITATIVE METHODS ?

- Agrifood SCM are complex systems
- Methods for solving Agrifood SCM problems:
  Qualitative (Symbolic) → Solved by Human
  Quantitative (Numeric) → Computer
- Advanced development in computer science and technology
  - increase the use of quantitative methods
  - Quantifying the qualitative factors :
    - Expert System, Fuzzy Logic, Reasoning (Study of the Mind), etc
    - Replacing experienced managers and experts in decision making

Quantitative Methods:

- **Statistics**
- **Industrial Engineering and Management Science Tools:**
  → Plant-layout and Material Handling
  → Production Planning and Inventory Control
  → Forecasting, Material Requirement Planning, Aggregate Planning, etc
- **Decision Making and Optimization Tools:**
  → Linear and Non-Linear Optimization Techniques
  → Multi-criteria and Multi-objective Optimization
  → Simulation, etc
- **Advanced Tools (Present and Emerging):**
  → Meta-heuristics
  → Artificial or Computational Intelligence (GA, FL, NN, etc.)
  → Agent Based Modeling
  → Super, Quantum and Nano Computing, etc.

Artificial Intelligence : State of The Art

- Sejak puluhan tahun yang lalu manusia telah berusaha membuat MESIN PINTAR (mesin yang memiliki kemampuan BELAJAR dan BERPIKIR seperti manusia) → dipicu dengan ditemukannya KOMPUTER

- Pada awalnya, komputer hanya mempunyai kemampuan untuk BERHITUNG (TO COMPUTE) → EDP (Electronic Data Processing)

- Seiring dengan kemajuan teknologi, kemampuan komputer terus bertambah menjadi SYMBOLIC PROCESSING (HUMAN-LIKE ACTIVITY)

  Meniru proses belajar dan berpikir seperti yang dilakukan manusia

- Hal ini memicu lahirnya ilmu baru → **Artificial Intelligence**

The Technology behind The Intelligent Systems

1) Fuzzy Logic (Logika Samar)

→ Meniru manusia dalam hal interpretasi / sensorik

→ Dipakai dalam bidang teknik (ex: automatic control, kamera, mesin cuci, microwave), dan manajemen (ex : Group Decision Making / konsensus)

2) Neural Network (Jaringan saraf Tiruan)

→ Meniru otak manusia dalam memproses data atau informasi (parallel processing).

→ Dipakai dalam bidang pattern recognition, vision recognition, voice recognition, dll.

3) Expert System (Sistem Pakar)

→ Meniru keahlian yang dimiliki seorang pakar di suatu bidang tertentu

→ Dipakai dalam bidang kesehatan (diagnosa penyakit), manajemen (perekrutan pegawai baru, strategi pemasaran), dll

4) Genetic Algorithms (Algoritma Genetika)

→ Teknik optimasi (berbasis komputer) yang meniru proses evolusi makhluk hidup

→ Dipakai dalam bidang penjadwalalan, desain sistem produksi, investasi dll

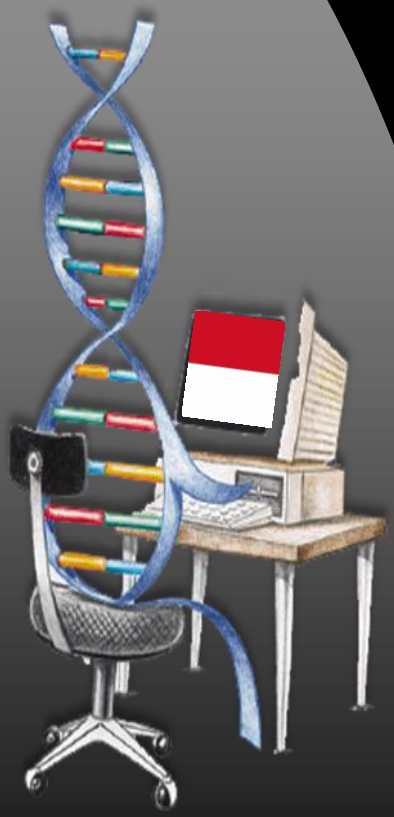
- Artificial
  - Produced by human art or effort, rather than originating naturally.
- Intelligence
  - is the ability to acquire knowledge and use it
- **So AI was defined as:**
  - AI is the study of ideas that enable computers to be intelligent.
  - AI is the part of computer science concerned with design of computer systems that exhibit human intelligence

Intutition vs Quantitative Methods

Traditional Tools (Intuitions, Judgments and Rules of Thumbs)	Modern Tools (Quantitative, Scientific, Knowledge-based and Intelligent)
Manual	Computer-based
Inconsistent	Consistent
No Explanation	Explanation Capability
Imprecise	Precise (e.g. with Fuzzy Logic)
Small-scale and simple problem	Large-scale and complex problem
Limited learning capability	Unlimited learning capability (with super-computer)

Examples of Application of AI in Agrifood SCM Design

An Integration of Multi-objective Genetic Algorithm and Fuzzy Logic for Optimization of Agroindustrial Supply Chain Design



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A Fuzzy Expert System For Predicting *Pandan Wangi* Paddy Productivity In Indonesia

Yandra Arkeman, Muslim Al-Khanif, Agus Buono,

Kudang Boro Seminar

Thank You