Framework development of Knowledge/Information headquarters (KIH) for less-unsustainable resource-productive society

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1 What is knowledge/information headquarters (KIH)?
Motivation of research

• Market mechanism = assumption that all players have perfect information?
• Reality = most of players have insufficient information because of
  – the increasing complexity of environmental issues
  – associated fragmentation of academic and professional domains into more profound and detailed pieces,
• Here, the need is emerged to develop the framework of well structured and knowledge/Information.
Framework is called as Knowledge and Information Headquarters (KIH), Then what’s that?
Knowledge and Information Headquarters (KIH)

- Accessible for various agents such as citizens, academics, industrial sectors, governmental agencies, etc.
- Provision of structured information & knowledge
- Neutral to specific stakeholders and views/aspects
- Voluntary donation of information/knowledge by give and take basis
What kind of knowledge information is supplied through KIH?

The KIH platform involves a body of

- facts and data base
- achievements of scientific research
- empirical knowledge and lessons from ‘good practices’ and failures/environmental disasters
- actions, initiatives and policies undergoing
- tool kits for operation
Case studies done in FY2002 suggested…

- Potential of KIH as the workable platform of structured knowledge/information for rational decision making
- To realize potential of KIH in practical decision making, the functions of searching, extracting and editing for specific views need to be sophisticated.
Research in FY2003

• Case studies to realize the relation between knowledge/information utilization and decision making process

• Focus on prototype development of ‘Configuration Engine’
Decision making by stakeholders

- decision making is a process to create solution for the specific requirements that the stakeholder faces.
- In the process of creating solution, various forms of information and knowledge are collected.
‘Nodes of knowledge’ utilized in decision making

- technical documents including regulations, standards, specifications, guidelines, manuals and textbooks
- software
- visual presentation
- aural advices and suggestions
- tacit knowledge embodied with stakeholders
Configuration Engine

Requirements
Ever changing turbulent environment

Decision Making

Solution

Configuration engine

Nodes of knowledge

Boundary

Domain

Inducing of nodes of knowledge

Node
The function of a configuration engine

- Extraction of various nodes of information and knowledge from a set of nodes of information and knowledge.
- Editing of extracted knowledge and information by networking of nodes of information and knowledge beyond domains to let them usable to create solution to specific requirements.
- ‘Configuration engine’ is an enabler for dynamic cross-domains networking of nodes of information and knowledge.
Performance of ‘configuration engine’

Defined by degree of enabling ability of;
• extraction of most appropriate nodes of knowledge beyond the fixed domains
• well coordinated network building of nodes of knowledge beyond interfaces of nodes
• dynamic borrowing of nodes of knowledge from various sources
Methodology

• Identification of structure of stakeholders’ decision making process

• Case study approach to identify the relation between knowledge/information utilization and concerns of stakeholders in real decision making process.
  – decision making process of various stakeholders involved in logistics of biomass wastes.
  – dialogue between players in product life cycle of PET bottle.

• Proposal of primary idea of the structure of ‘configuration engine’ as an instruments within KIH.
2 Case study

on decision making process
in logistics of biomass wastes.
Biomass

Biomass resources are ‘all non-fossil organic materials that have an intrinsic chemical energy content. They include

• all water- and land-based vegetation and trees

• all waste biomass such as
  – municipal solid waste (MSW)
  – municipal biosolids (sewage)
  – animal wastes (manures)
  – forestry and agricultural residues
  – certain types of industrial wastes
Utilization of biomass

Biomass resources are utilized through the plant facilities that produce

• electric power by using biomass as a primary or secondary feedstock or by co-firing biomass with a traditional fuel
• ethanol or bio-diesel.
• bio-based products from biomass resources including
  – agricultural crops and trees
  – wood and wood wastes and residues
  – Plants
  – Grasses
  – Fibers
  – animal wastes
Logistics of biomass

the efficiency of facilities has been and is being improved
However,

The efficiency of ‘procreation to exit gate’

The efficiency of ‘procreation to entrance gate’

The efficiency of ‘entrance gate to exit gate’

Site of procreation

Sorting Plant

Recycling Plant

Final products
Nature of biomass logistics

• The efficiency of ‘entrance gate to exit gate’ is being improved by innovation in processing industry.

• However, procreation of many of biomass resources is not regular and stable in terms of geography and time.

• Temporal instability and geographical irregularity of emergence of biomass resources constrain the efficiency from ‘procreation to exit gate’

• the comprehensive efficiency of utilization of biomass resources is dominated by the efficiency of biomass logistics
Networking of logistics of biomass

• Networked by a set of transactions between multiple agents that are supposed to be one-shot, ad-hoc basis.
• Need of ‘effective’ intervention on those sorts of one-shot, ad-hoc basis transactions by provision of well structured information and knowledge through KIH could be the effective intervention
  – to improve the efficiency of biomass resource logistics
  – to generate and activate new types of transactions that are preferable from the aspect of biomass resource utilization.
Players of biomass logistics

- Procreator of biomass resource,
- Agent located in or concerned in the immediate environment around the site of specific biomass resource creation
- Transporters of biomass resource
- Sorting plant agents
- Recycling or final products’ plant agent
- Brokers of biomass resource
- Distributors of biomass resource
- Customers of final products
Redundant capacity of recycling plant
Vs. Redundant wastes
Interview survey to ‘agents’

• focuses on logistics of industrial-waste-based-wooden biomass resources
• to clarify factors that are influential on the determination of business partners in the transaction of industrial-waste-based-wooden biomass resources.
• Identified factors are categorized into
  – Embodied (attributing) factors with agents
  – voluntary factors that relevant to concerns of agents
  – circumstantial factors
Procreator of wooden wastes

**Embodied factors**
- Phase and duration of time of wooden wastes procreation
- Quantity by quality of procreated wooden wastes
- Geographical location of procreation

**Voluntary factors**
- Preciseness of sorting in procreating site

**Sorting plant**

**Embodied factors**
- Capacity of processing
- Performance of screening
- Capacity of stock-yard
- Wastes generation ratio from processing
- Geographic location

**Voluntary factors**
- Strategic/tactic flexibility of charges or prices of wooden waste
- Charges to mixture waste

**Circumstantial factors**
- Long term expectation of demand/supply
- Short term stability and turbulence of demand/supply
- History and expectation of continual business relation
- Geographical allocation of sorting plants
- Transportation conditions

**Offer of wooden wastes**

**Offer charges to processing**

**Negotiation**
Limited information and knowledge (1)

- agents do not have sufficient knowledge and information on embodied factors and voluntary factors of counterpart of possible transactions
- agents do not get sufficient knowledge and information on circumstantial factors such as
  - long term expectation of demand/supply
  - short term stability and turbulence of demand/supply
  - history and expectation of continual business relation
  - geographical allocation of sorting plants
  - transportation conditions.
Embodied factors
• Performance of sorting
• Capacity of stock-yard
• Geographic location

Voluntary factors
• Strategic/tactic flexibility of charges or prices of wooden resources
• History and expectation of continual business relation

Circumstantial factors
Regional demand/supply balancing of wooden tips
Regional demand/supply balancing of final products
Short term stability and turbulence of demand/supply of wooden tips and final products
Geographical allocation of sorting and recycling plants (alternatives of transactions)
Probable environmental impacts and contamination transportation conditions regulations

Embodied factors
• Capacity of processing
• Acceptable kind of wooden resources
• Maximum quantity of acceptable resources by kind
• Geographic location

Voluntary factors
• History and expectation of continual business relation

Offer of wooden tips

Announcement of prices of wooden tips

Announcement of acceptance or rejection
Limited information and knowledge (2)

• Recycling plant do not have sufficient knowledge and information on embodied factors and voluntary factors of all sorting agents that offers wooden tips.
• Agents do not have sufficient knowledge and information on circumstantial factors such as
  – long/short term regional demand/supply balancing of wooden tips and final products
  – short term stability and turbulence of demand/supply of wooden tips and final products
  – probable environmental impacts and contamination, regional transportation conditions
  – relevant regulations
  – possible alternative business partners.
Verification of assumed structure of decision making

- If the simulation model based on assumed mechanism accords with reality, it could be verification of assumed model. If not, assumed model needs to be modified.
- Verified model could be used to anticipate the impact by specific policies
Multi agent simulator (MAS)

• based on the assumption that the system is composed of a group of autonomous agents.
• can define different rules to each agent.
  – each agent has its own concerns/aspects of the world and its own objectives, but is capable of coordinating these objectives with respect to remote agents
• has potentially usable as stock market simulations using a different genetic algorithm for the simulation of each individual trading agent
• can be seen as a very recent merger of techniques from Complex Adaptive Systems (CAS) and Distributed Artificial Intelligence (DAI).
Agents’ criterion of concern

Autonomous decision making in each transaction by each agent is defined by unique criteria of concern that include:

- Anticipated level of prices/costs that a counterpart of transaction would agree with
- Long term expectation of demand/supply
- Short term stability and turbulence of demand/supply
- Capacity of plant
- Performance of plant
- Geographical proximity and transportation conditions
- Purity and variance of quality
- History and expectation of continual business relation
Difference in
• the priority of criteria
• availability of knowledge and information

Price ?
Proximity ?
Continual relation ?
Reliability on quality ?
Capacity of facilities ?
Agent A

Selection rule by Agent A
Price ?
Proximity?
Continual business relation?
Reliability on quality?
Capacity of facilities?

Agent B

Selection rule by Agent B
Price ?
Proximity?
Continual business relation?
Reliability on quality?
Capacity of facilities?
Verification process

- The mechanism model of decision making presumed by interview survey is translated to the algorithms of multi-agent-simulator (MAS).
- In the translation, priority are assumed
  - For instance, criteria of history and expectation of continual business relation get higher priority than criteria of certain range of price level.
Comparison between reality and output by MAS

• By comparison of output and reality, rules of each agent are modified, then the revised model is simulated.
• By repetition of these heuristic processes, so far, obtained model on logistics of industrial-waste-based wooden biomass resources successfully reach to the similarity of reality.
• Therefore, the assumed structure could be the basis of design of ‘configuration engine’ for agents
Reality: Capacity of plants
Reality : Input and output of plants