Hi friends, all the best for finals~

-Yu Ting

1a)

| Economic | Socio-political | Structural-operational |
|---|---|---|
| ● Incentives (Rebates, tax credits)<br>● Disincentives (Real costs, penalties) Eg PUB raising water prices | ● Policy to promote water saving devices<br>● Controlling types of devices sold | ● Reduction of UFW<br>● Installation of water saving devices (eg delay action self-closing taps)<br>● Rationing |

1b)

UFW = Net Production – Legitimate Consumption (Billed & Unbilled)

NRW = Net Production – Billed Legitimate Consumption

Therefore, NRW = UFW + unbilled legitimate consumption (water accounted for but no revenue collected)

UFW due to REAL (leaks, pilferage) and APPARENT losses (meter inaccuracies), usually due to lack of maintenance in network

1c)

Direct non-potable use: Air conditioning

Indirect potable use: Mix with reservoirs and supply to homes

Challenges: Potential long-term health impacts, Psychological barriers

1d)

Sources: Urban runoff, rising sea levels

Measures: Controlling pollution at source. Separate sewerage and drainage systems therefore this protects local water supply reservoirs

2a)

- Magnitude
- Significance
- Temporal/Duration
- Spatial/Area
- Direct/Indirect
- Reversible/Irreversible
- Actual/Perceived
- Random/Predictable

2b)

Baseline study involves collecting info (topography, air/water/land pollution, ecology) before project starts and continuous monitoring afterwards + conducting post-audit. EMMP is a monitoring plan to ascertain impacts of project activities on applicable environmental parameters and confirm impacts have not exceeded the stipulated environmental quality objectives for the project.

2c)

Advantages: Greater control over process. Less administrative costs. Avoid long delays on project due to legal arguments

Disadvantages: Difficult to force agencies to take responsibilities seriously. Public may not be able to challenge unfavourable decisions

2d)

| Cost | Benefits |
|---|---|
| Natural resource depletion | Sustainable development |
| Social dislocation | Economic growth |
| Traffic congestion | Reduced travel time |
| Threat to wildlife | Protection of wildlife habitats |
| Air/water/land pollution | Preservation of cultural assets |
| Threat to cultural heritage/conservation areas | Contribution to infrastructure |

2e)

- Source and Inlet control – manage pollution at source
- Site control – more control further downstream
- Regional control – even larger downstream control
- Conveyance control – via drainage channels

3a)

Context of organisation – workforce, geography, culture, legal and other requirements

Improvement – Enhancement of OHS management system eg via policy/management changes

Intended outcomes – Prevent injury and/or ill health to workers, provide healthy, safe work places

Internal issues – Issues resulting from factors within organisation such as management hierarchy, company policies

External issues – Issues resulting from factors outside organisation eg new legislation/law

Leadership – Top management setting the foundation for safety management system by developing and maintaining a culture that supports the organisation's intended outcomes of management system

Needs & expectations – Requirements and standards the organisation has to abide by

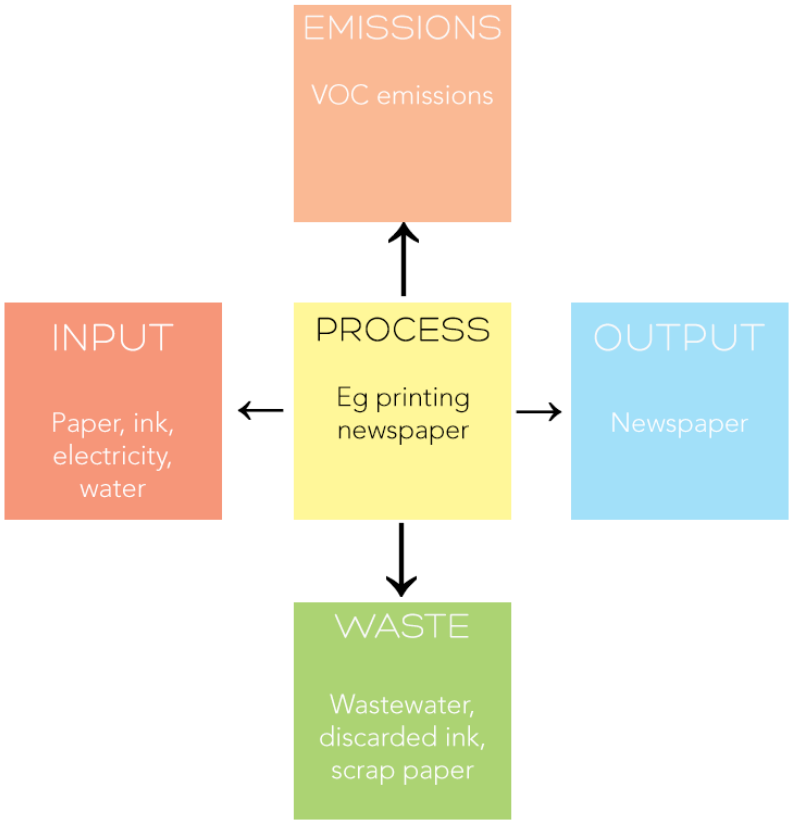
Performance evaluation – Determining performance of OHS through certain requirements to be met

Planning – Establish environmental/safety and health objectives and processes in order to abide by the organisation's policies

Scope – Focus area in terms of various aspects of safety/location etc

Support & operation – Lower levels of management supporting top management by following and executing policies implemented by top management

3b)



4a) (i) Common property refers to goods that are involve non-excludable, rival consumption

4a (ii) Hedonic pricing refers to when the price of marketed goods are related to its characteristics or services provided (Eg housing prices). Most often used to estimate economic values for ecosystem or environmental services that directly affect market prices. Can also use to associate economic benefits with environmental attributes.

4b) Each plants will emit as many units of GHG such that MAC = C = tax rate

Abatement by same amount will be efficient at society level since both plants share the same abatement cost function.

4c (i) CO, unburnt hydrocarbons, dioxins, furan, particulate matter (fly ash, dust), acid gases ($SO_x$ , $NO_x$ )

4c (ii) For every 1 kg of refuse,

Energy content = 1000kJ

Loss during incineration process = 25% of 1000kJ = 250kJ

Useful heat in turbine = 85% of (1000-250) kJ = 637.5kJ

Energy generated = 96% of 637.5kg = 612kJ

In-plant electrical power usage = 20% of 612kJ = 122.4kJ

Process fuel usage = 10% of 612kJ = 61.2kJ

Net energy left for sale = 612kJ – 122.4kJ – 61.2kJ = 428.4kJ

4c (iii)

Temperature – Higher temperatures favourable in combustion and prevents formation of dioxins

Time – Longer time for combustion further ensures complete combustion to reduce emissions of CO and unburnt HCs

Turbulence – Provides mixing for uniform and more complete combustion

5a (i) Global industrial economy will lead to more effective utilisation of resources via the concept of industrial ecology, where the waste or by product of one process is used as an input into another process. There will be a move from a linear to cyclical or closed loop system so resources can be more effectively used before final disposal and less primary resources can be consumed.

5a (ii) A water reclamation plant (WRP) and integrated waste management facility (IWMF) can achieve industrial symbiosis and benefit and co-location through the sharing of resources. For example, energy generated from IWMF can be supplied to WRP. Treated water from WRP can be used for cooling in IWMF.

5b (i) MFA is a systematic assessment of the flows and stocks of materials within a system in space and time, eg the input and output of wastewater in a WWT plant. LCA is a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. For example the life-cycle of a Styrofoam plate can be analysed

5b (ii) MFA strives for transparency while LCA aims for details and completeness

5b (iii) In waste-water treatment, alum is a common chemical used during coagulation stage. MFA analysis would analyse the inflow of alum and wastewater and production of other products resulting from the chemical reactions and outflow of water within the coagulation tank established as a boundary. LCA would analyse alum itself from the stages of manufacturing to its use and final stage.

5c) Main cause is attributed to the improper handling and/or disposal of hazardous waste materials.

6 types are: Nuclear/Industrial/Universal/Medical/Construction/E-waste

5d) EPMA requires industries that store/transport toxic substances:

1. Use a method of storage, operation or process to prevent water pollution
2. Install and operate pollution monitoring equipment to prevent and detect any leakage or discharge
3. Carry out specific tests on equipment, tanks or any other related facilities and to submit the results of these tests
4. Prepare and submit contingency plan for events of accidental discharge
5. Conduct studies on pollution control
6. Self-monitor
7. Take mandatory insurance
8. NEA can arrest offenders, enter any premise for investigation, search or seize any records if they believe discharges are being made without license