

# CHAPTER 9

## MAKING THE TRANSITION TO A MANAGED DISTRIBUTED INFORMATION NETWORK ARCHITECTURE: A WASTE MANAGEMENT NETWORK

**Rogers W'O Okot-Uma**  
Commonwealth Secretariat  
Marlborough House  
Pall Mall, London SW1Y 5HX  
Tel:+44 171 747 6339 Fax:+44 171 747 6335  
Email:r.okot-uma@commonwealth.int

# **Making the Transition to a Distributed Waste Management Information Network: *A Systems Development Framework***

## **Introduction**

Information is an essential commodity in any attempt that seeks contain contextual environmental problems and find new ways of managing limited resources. Diverse interests and perspectives often interpret the same data in radically different ways. For a potential user-base comprising a network of countries, the necessity arises, therefore, to present information in a data mode that is un-ambiguous, consistent and in a consensual common format. The potential contribution which a rapid transition to an information-based society can make to sustainable development cannot be over-emphasised. Making the transition to a distributed waste management network provides a systems development framework within which countries near or far and wide apart can share waste management information and best practices between and within themselves. The contribution which information and communication technologies (ICTs) can make with regard to the enhancement of waste management is deployed within the context a managed network topology based on the use of the Internet and its medium the world wide web (WWW). The article is amenable to re-use for design of similar information networks based on the managed network architecture principle.

Common environmental issues are the result of direct and indirect physical, chemical and biological pressures exerted on the environment by activities of anthropogenic origin, for the purpose of economic development. Environmental policy development is the identification of environmental concerns and agreement of solutions within various contexts and stakeholders. Sustainable development policies seek to strike a balance between economic, social and environmental goals or “securities”. Key challenges in any attempt to develop an information system to support decision-making and management pertain to an understanding of a number of questions. With regard to waste management, answers to such questions may be perceived to form the essence of the basis for a systems development framework for a Distributed Waste Management Information Network (Waste\_Net). This is depicted in Figure 9.1 (see pp 120).

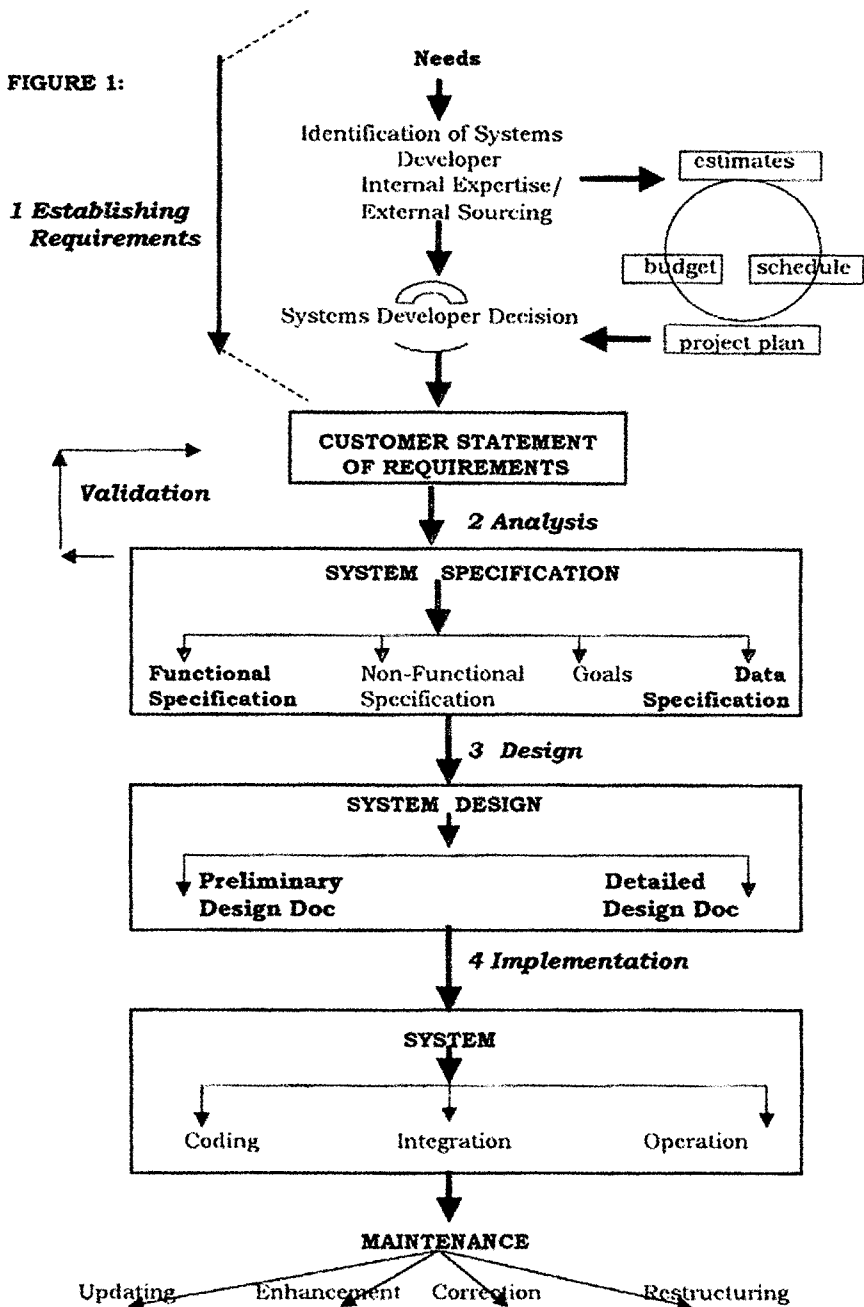


Fig. 9.1 A SYSTEMS DEVELOPMENT LIFE CYCLE

# Information Needs Analysis

**Information Needs Analysis** with regard to Waste Management will comprise that process whereby the *needs of stakeholders* - expressed in a variety of ways, namely, narrow, broad, technical or bureaucratic, are guided into a consistent, mutually agreed, set of information objectives on waste management. It focuses on a series of basic questions concerning waste management information usage, hence defining the context for the intended waste management information network:

Information needs analysis is an important early state in the systems development life-cycle, during which methods of collaboration between *providers and users* are established. It is proposed that such analysis is conducted in a consultative, inclusive manner, if benefits of various kinds are to accrue, which are of practical value, such as the following:

- Cost-effectiveness;
- Efficiency; and
- Strategic alliance and partnership.

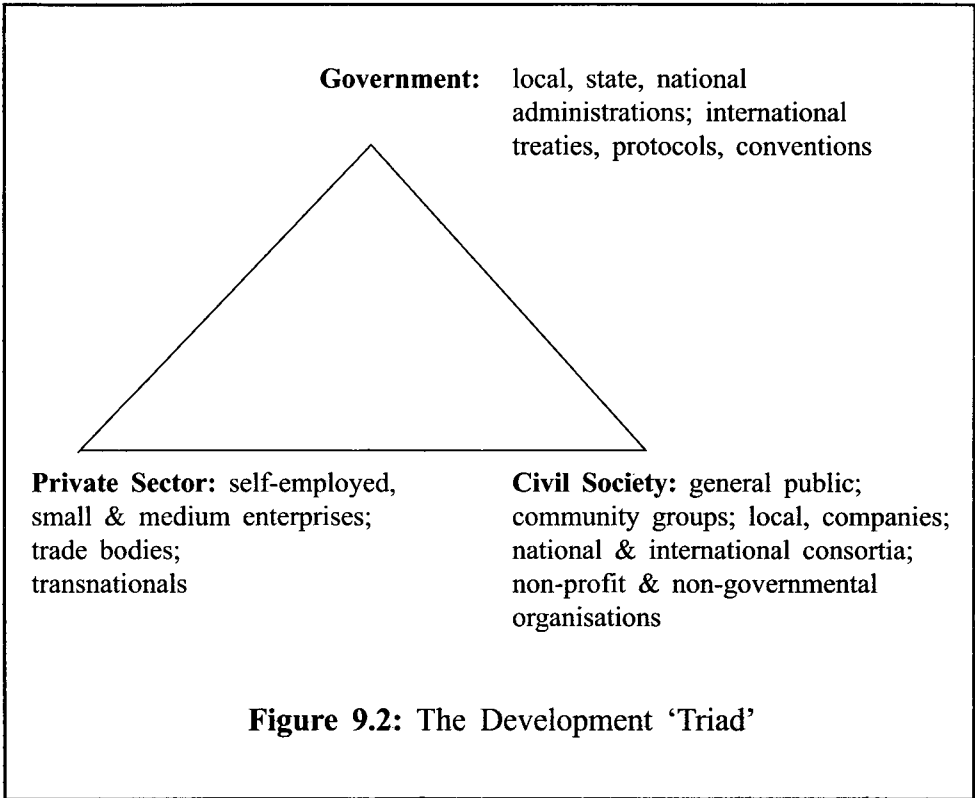
An indication of the importance of information needs analysis may take up to 80% of the start-up phase (Richardson, 1994).

## (a) Policy Analysis Questions

- What are the main goals with respect to the need for a waste management information network?
- Who are the stakeholders or intended users for the proposed system?
- How do the stakeholders currently make use of waste management information?
- What are the broad constraints that may affect the use of the proposed waste management system?
- What plans, legislation and regulations might affect the development and use of a waste management information network?
- Over what time-scale is the information content of the network needed?
- How often will the information network be used?

It is conceivable to note that for the case of the proposed system, the

stakeholders will be a *subset* of the categories formed by government, private sector and civic society which, together, may be referred to as the Development 'Triad' (Sandbrook, 1994). This depicted in Figure 9.2.

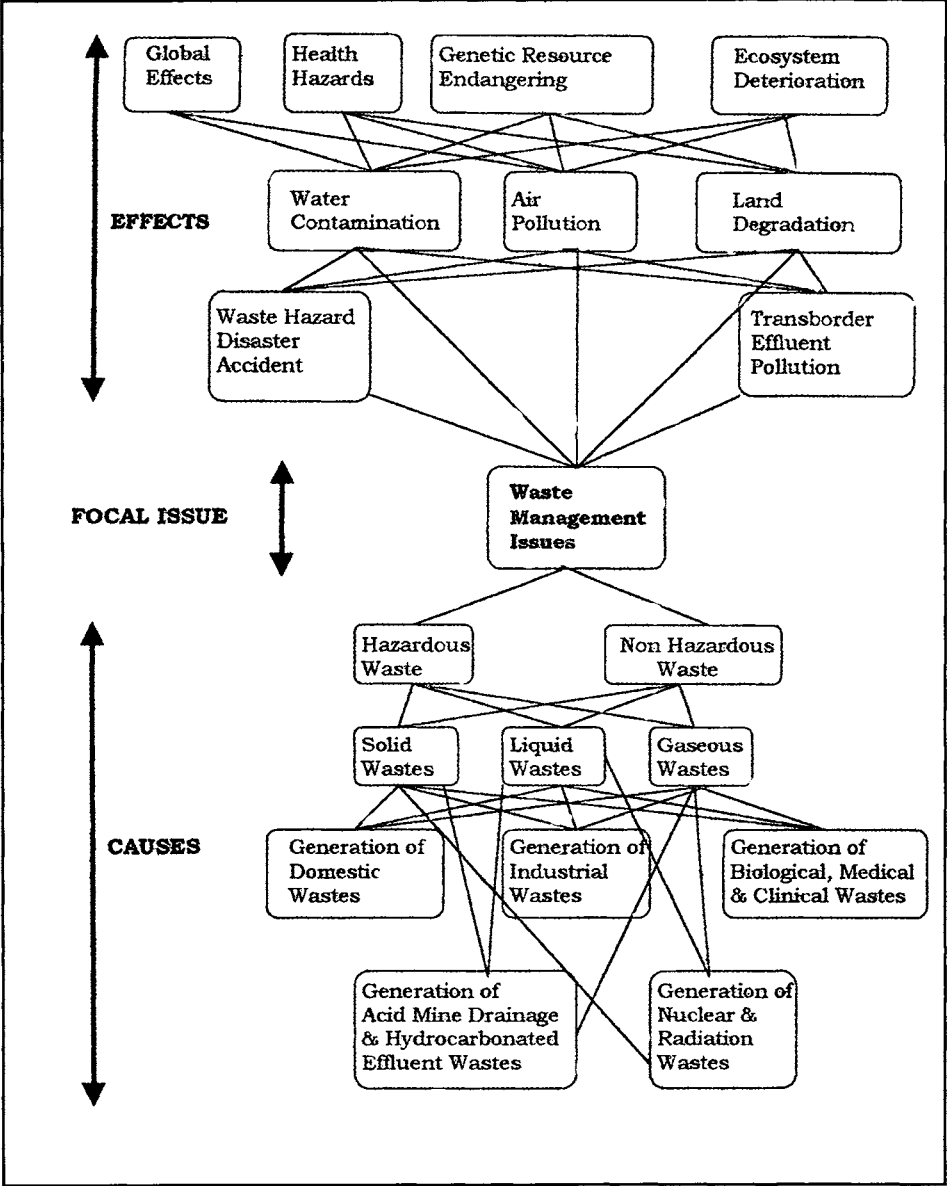


## (b) Policy Support Mechanisms

The next step towards addressing the issue under consideration is for stakeholders to *integrate their various needs and perspectives into a common vision*. This may not suit all stakeholders perfectly, but the aim is to find a solution to the issue which combines as many social, economic and ecological demands as is feasible, given the diversity of perspectives. A key element of this process is *consultation and consensus-building*, which can be structured using a number **tools** and **methods** and facilitated by objective concerns. Structured approaches include Questionnaires and Interviews. Group Approaches include Stakeholder Analysis, Visioning Exercises, Brainstorming, Problem tree Analysis, Working Groups and Workshops.

The aim of a **Stakeholder Analysis** is to determine which groups are most relevant to an issue, policy or project. Inviting too many stakeholders to participate in the process of consensus-building can lead to high overall costs, prolonged consultation periods, introduction of extraneous issues and the

possibility of conflicts arising. Inviting too few stakeholders could imply that some groups have been overlooked or excluded, leading to resentment and increased likelihood of non co-operation. Whatever choice is made, it is important that the project is perceived to be owned by the stakeholders. **Problem Tree Analysis** is a useful method for enhancing problem definition so that strategies can be formulated to address their underlying causes. A fragment of problem tree analysis is depicted in Figure 9.3 below for waste management.



**Figure 9.3:** Problem Tree Analysis for Waste Management

## Customer Statement of Requirements

The **Customer Statement of Requirements Phase** pertains to what specific information under the broad area of waste management is *required* by whom and in what form to enable stakeholders to confirm their consensual disposition with regard to the proposed Waste Management Information Network. Customer Statements of Requirements will *provide an informal description of the properties of the proposed information network, written in natural language and expressed in terms of application terms rather than computing terms*. Essentially, the content of the Customer Statement of Requirements will detail an identification of the required purpose of the system as perceived by *the customer*.

A fragment of the Customer Statement of Requirements might state as follows:

- The system should enable *country profile data* on WorkGroup members to be inputted, stored, searched and outputted;
- The system should enable *specific information on members of the WorkGroup* to be searched on a country by country basis;
- The system should enable *country profile data* on WorkGroup members to be accessed in either a *centralised database* at one specific physical location or a *distributed database* at geographically disparate locations;

## System Specification

**Systems Specification** represents a *description of the characteristics of the proposed system as perceived by the systems developer*. The only way to check that requirements analysis has been carried out correctly is by asking the customer to check the systems specification against the customer's statement of requirements.

System specification should be partitioned to include both Horizontal and Vertical Partitionality:

(a) **Horizontal Partitionality** refers to the the separation of system specification into the following component:

- Functional Specifications.
- Non-Functional Requirements.
- Data Requirements.

## Goals

Functional Specifications pertain to WHAT the system is expected to do and not HOW the system should carry out a function. As an illustrative fragment of a functional specification, it is conceivable that the proposed system should be able to do the following:

- Define a Country Profile Format for Waste Management:**
  - Eco-Development Data Summary.
  - Environmental Organisational Framework.
  - Environmental National Strategy.
  - National Accession to Environmental Conventions and Protocols.
  - Waste Profile Classification by Sector
  - Legal Instruments for Waste Management.
  - National Quality Standards for Air and Drinking Water.
  - Summary of Documented Impact Studies.
  - Summary of Documented Good Practices in Waste Mitigation and Disposal.
  - Summary of Documented Good Practices in Specific Areas of Waste Management.
  - Examples of Successful Government-Private Sector Partnership Projects in Waste Management.
  - Examples of documented Disaster Preparedness Guidelines in the Event of Specific Hazard Waste Accidents.
  
- Search and Display by Country:**
  - Summary of waste management policy, policy principles and national strategy, whether explicit, implicit or non-existent;
  - Listing of organisational and institutional frameworks with functional responsibilities for waste management;
  - Summary of *waste management legal instruments*;
  - Summary of *waste classification listing* by the following categories:
    - (a) solid, liquid, and gaseous wastes;
    - (b) hazardous solid, hazardous liquid, hazardous gaseous wastes;
    - (c) industrial, biomedical/clinical, nuclear/radiation wastes;
    - (d) mining wastes.

- ❑ Summary of *national quality standards* with regard to the following;
  - (a) Air;
  - (b) Drinking water;
  - (c) Agricultural water
  
- ❑ Summary of *waste impact studies* on:
  - (a) air, soil and water quality;
  - (b) flora, fauna, habitats and ecosystems;
  - (c) agricultural and forestry resource.
  
- ❑ Summary of proven good practices in waste mitigation and disposal technologies deployed in specific wastes in the following categories:
  - (a) waste avoidance;
  - (b) waste reduction;
  - (c) waste recycling/reuse;
  - (d) waste treatment; and
  - (e) waste disposal.
  
- ❑ Summary of proven good practices in waste treatment and disposal wastes in the following categories:
  - (a) solid waste;
  - (b) liquid waste;
  - (c) biomedical/clinical waste; and
  - (d) hazardous waste.
  
- ❑ Summary of Case Studies and Best Practices in various areas of waste management, including the following:
  - (a) EIA for sanitary fills;
  - (b) Health EIA for personnel exposed to named occupational hazardous wastes;
  - (c) Landfill practices;
  - (d) Biomedical waste disposal;
  - (e) Nuclear waste treatment, containment and disposal; and
  - (f) Scavenging.
  
- ❑ Summary of Waste-related Conventions and Protocols to which a country is signatory.
  
- ❑ Examples of Government-Private Sector partnership in waste management.
  
- ❑ Examples of Good Codes of Practices in the event of a hazardous waste accident *in-situ* or in transit.

## Non-Functional Requirements

As well as statements of function, a customer statement of requirements will contain Non-Functional Requirements.

- In the fragment of customer statement of requirements above there is the **design and/or implementation directive** that the future system should conform one of the following network topology options:
  - (i) **Centralised Network architecture**, in which the information systems located in one, central location, with nodes (partners) supporting this as necessary. Here the central node may be perceived as controlling access to data and information products, thus providing difficulties to establish a ‘co-operative’ spirit.
  - (ii) **Fully-Distributed Network architecture**, in which nodes (partners) operate in an unrestricted environment, communication is encouraged between all parties, and no attempt is made to co-ordinate or control the partnerships. Here the information is spread across all network nodes, namely, the network is the system, nodes are not co-ordinated or provided with direction, resulting in possible duplication of effort, lack of agreed standards and generally impeded progress towards common information objectives.
  - (iii) **Managed Network architecture**, in which nodes (partners) communicate free between themselves but co-ordination and other network services is provided through a ‘hub’ which serves the collective interests of all network partners rather than the specific interest of a single node.

A managed network architecture topology may be selected for ease of co-ordination and collective integration.

- The necessity to realise a distributed architecture in which partners of the network are located in different countries, points to the need to develop a system that conforms to a designated method of delivery, namely, one which is Internet-based and which makes use of the expedience and the potential of the World Wide Web (WWW).
- The choice to develop WASTE\_Net on the Internet and the World Wide Web in itself leads to **Hardware and Software constraints** in relation to the pertinent information and communication technologies (ICTs). To be able to participate in the project, access to the Internet and the World Wide Web be will desirable with certain minimal requirements:

## *PC Requirements*

At least a 486 DX66 IBM-compatible PC, equipped with 16 MB RAM to get either Internet Explorer or Netscape to function under Windows 95/98/3.x, and 24-32 MB to run other programs at the same time.

Windows NT versions demand at least 32 MB of RAM: depending on which optional components are desired for installation. Netscape 4.x requires between 18 and 30 MB of hard disk space, and Internet Explorer 4.x and 5.x, between 40 and 80 MB.

Windows 2000, which incorporates Internet Explorer 5, demands at least Pentium 133, with 64 MB of RAM.

## *Mac Requirements*

A **PowerPC processor** is desirable for running Internet Explorer 4.5, Netscape Communicator 4.7x, and later versions of both. Internet Explorer 4.5 and 5.x will run on **MacOS 7.5.3 or later**, and 12 MB of RAM. Netscape 4.7x requires 16 MB of RAM if running **MacOS 7.6.1**, and 24 MB of RAM, for MacOS 8.0 or greater.

## *Other PCs*

For older machines running Windows 3.1, a best choice for the browser is **Internet Explorer 3.03**. It can function on a 4 MB of RAM and as little as 7 MB of disk space for a browser-only installation, plus it also includes the TCP/IP dialling software that Windows 3.1 omits.

The Mac equivalent also requires somewhat less RAM and disk space than its successor. If that's still heavy, **Netscape 2.0x** is better than no browser at all.

Alternatively, one may investigate the less known but distinctly impressive **Opera** (<http://www.opera.com>). This packs a browser, mail sender, and newsreader into couple of MB.

You will find every browser ever released across all platforms for free download at: <http://browsers.evolt.org>.

For the implementation of WASTE\_Net, **no timing, schedule or budget** constraints have been stated. In practice, statements about these parameters would form part and parcel of the non-functional requirements. A statement that the proposed system will contain a specific content also forms part of the non-functional requirements whilst content stated in a functional form would form part of the functional specification.

## Goals

Goals relate to statements which guide the systems developer or systems designer where *choice or degree of freedom* exists. For WASTE\_Net, it may be assumed that there are no restrictions with regard to the following:

- Choice of programming language, standard or protocol;
- Deadline, timing or schedule for delivery of system; and
- Budget for the implementation of the system.

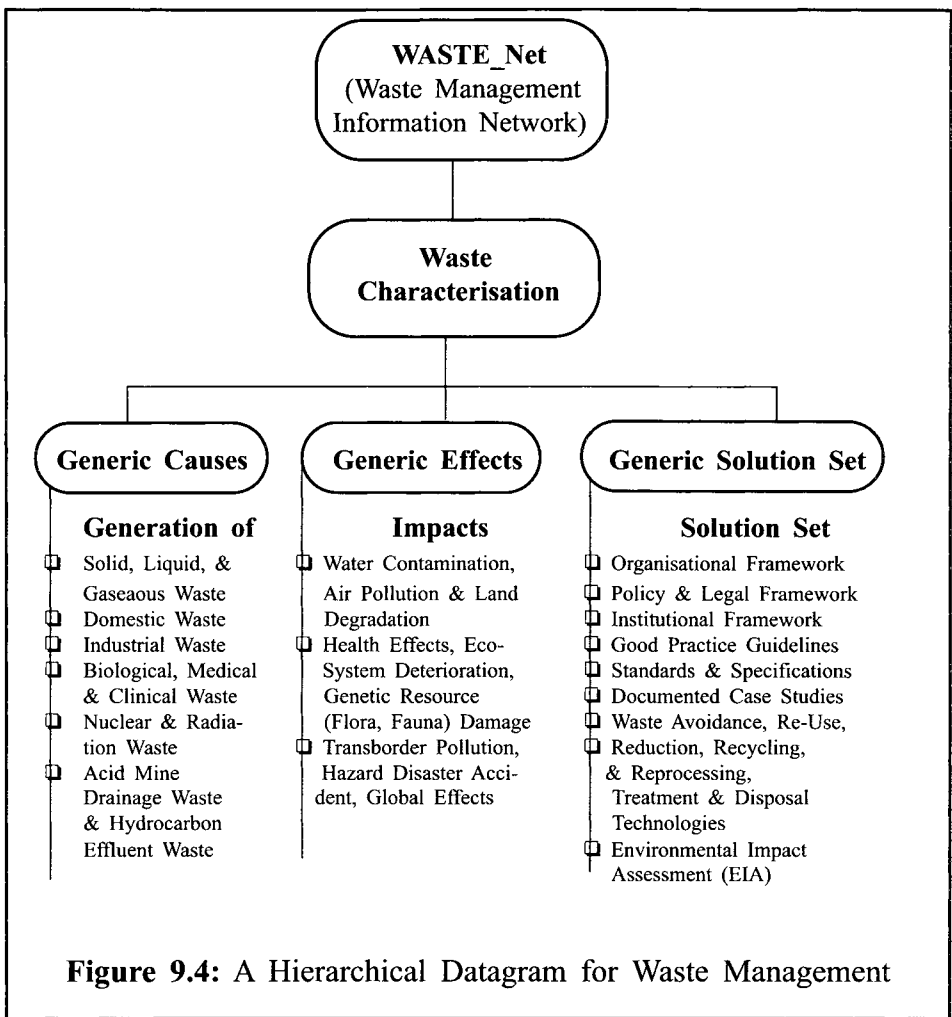
## Data Requirements

A statement of requirements may contain references to data used by the proposed system., such as the following:

- Statement on data structure of pertinent database sub-systems; and
- Statement on format of report forms.

For WASTE\_Net, the data structure will comprise a combination of standard dataset formats inherent in Web documents: textual, tabular, graphical and photographic.

(b) **Vertical Partitionality** represents the system specification into a series of levels of abstraction. Each level corresponds to a level of abstraction in the statement of requirements. This enables the specification to be examined by various interests at different levels of the development team.



## Implementation

Vertical partitionality with regard to datasets for WASTE\_Net may be represented in the hierarchical datagram above (FIGURE 9.4).

### (a) System Design

WASTE\_Net will comprise a distributed database on the World Wide Web, with a managed network topology. HyperText Mark-Up Language (HTML), with its complement of hyperlink facilities and multimedia capability, will be used as the “programming” language.

As a response to the fragment of functional specification provided above, a corresponding fragment of HTML code can be evolved, which sets up a Home page for WASTE\_Net, with sample information for a Hypothetical Sample Country Profile on Waste Management, and with hypertext linkages to Country Members of WASTE\_Net.

## **(b) Integration**

For a managed network, integration would comprise hyperlink pointers to corresponding Website addresses of the WASTE\_Net membership in the different countries. For the purpose of this article, hyperlink pointers will be limited to country profiles within a single hypertext document.

## **(c) Operation**

Operation of WASTE\_Net will be demonstrated on the basis of the fragment of functional specifications given above. Such a prototype should be able to provide a systems developer with good potential for expansion to include multimedia components of diverse kinds including diagrams, pictures, sounds and even animation.

## **(d) Maintenance**

Maintenance involves enhancement, adaptation and updating of various attributes of a system. WASTE\_Net, like any other hypertext database on the Internet and the World Wide Web, will need to be maintained at periodic intervals in order for the currency of the information therein to remain truly timely. The imperative for timely maintenance makes the choice of a managed network architecture for WASTE\_Net the more significant.

## **Conclusion**

WASTE\_Net as presented in this article is exemplary of the principles of systems development in the implementation of an information network for intra- or inter-collaboration among countries on an area of common interest such as waste management. It can be used by both the professional and the neophyte alike in initially building a pilot information network of their choice.

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