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A DEVELOPING INDUSTRIAL SYMBIOSIS IN LARGE CITIES USING BIG DATA

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Abstract: A big problem for industry and large cities is the increasing waste streams from households as well as industries and their impacts to the environment. Treatment of the waste is expensive, and cities face challenges on waste disposal sites. A sustainable solution would be to realize industrial symbioses. The typical approach is to design and develop industrial parks each of which is aimed to be an industrial symbiosis. This approach is proven by successful cases, but is constrained by land scarce cities as well as the limited types and scales of the companies that can be included in an industrial park. The paper proposes a big data analytics approach to realize industrial symbioses among the industries in a city's close proximity.

The waste streams and resource requirements of existing companies are identified and matched with resources needs directly or indirectly through conversion processes. The viability, critical elements and technical challenges of the approach are discussed.

Keywords:

Big data analytics Industrial symbiosis Waste management

1. Introduction

The world is becoming more urbanized along with the industrialization and economic growth. People are increasingly attracted to cities by higher paid jobs and quality of living. According to United Nations' report , urban residences is projected to grow from 54% of the current 7 billion pollution to 66% of the estimated 9 billion people by the year 2050. This translates to about 2.2 billion more people to live in urban areas. Among these people, 500 million is projected to live in the top 600 cities in the world . Coupled with the growth of cities in number and sizes is the challenge to tackle waste. Accordingly to World Bank , waste generated in world cities is expected to increase from about 1.3 billion tons per year at present to 2.2 billion tons by 2025. The amount of municipal solid waste per urban resident per day is projected to increase from 1.2 kg today to 1.42 kg by 2025. More than 50% of the waste comes from industrial, commercial, and institutions (ICI). During the period, the cost of solid waste management will increase from $205.4 billion to about $375.5 billion, and the cost increases will be more severe in low-income countries and lower-middle income countries. The ever-increasing waste in cities posts challenges to the environment and waste treatment Particularly in developing countries, investment cost and environmental concerns hamper the growth of waste incineration. Land constraints limit the capacity of waste disposal. The increasing complexity of substances in the waste due to complexity in the use of materials in products and packaging make it more difficult to recycle.

2. Literature survey:

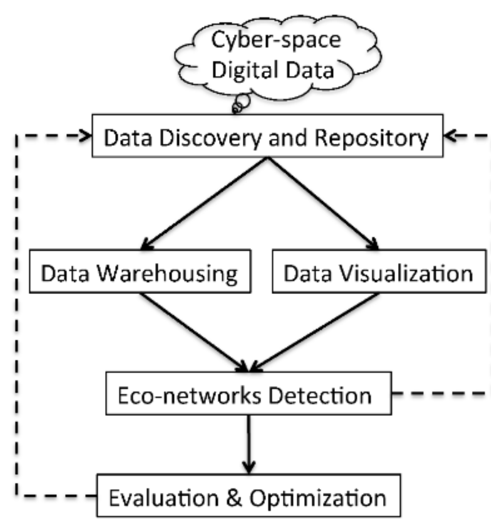

Figure 1: Solution Framework

3. Proposed System

Table 1 shows a summary of the data types, example data, and data sources under the structured and unstructured category. Here, required data from available open sources will be gathered using an automated web-crawler [20]. Data on registered names, addresses, type of businesses, products, etc. can be obtained from industrial directories. The basic data set would then be augmented and reconciled with further information. For example, their geographic locality (latitude, longitude) can be identified using geographic web services, possible inputs associated to a product and possible by-products can be derived from life cycle inventory databases, possible amount of outputs can be established using financial reports and possible waste output using information from waste exchange databases. Furthermore, for entities within the dataset which consist of sparse data after the data augmentation and reconciliation process, predictions can be made using clustering and classification techniques from entities that are richer in information. At the end of this stage, information regarding the materials, energy and wastes associated to entities in the industrial symbiosis network is established.

Table 1: Data and Open Data Sources

Data Type	Example Data	Possible Source
Structured data	Business type, addresses, product type	Company registration
	Known available waste streams	Waste exchange registry database
	Reported pollutant release and locality	National pollutant emissions inventory
	Geographical coordinates of entities	Geographical information system (e.g. Google Maps)
	Process input output	Life Cycle Inventory databases
Unstructured data	Sales and revenue	Financial reports
	Products & technologies Contact information Location	Information from company website
	Technologies & trends	On-line news
	Public sentiments Significant temporal trends	Social media
	Technologies Material characteristics Known uses of materials	Online encyclopaedias
	Industrial symbiosis case studies Novel technologies Alternative uses of materials	Journal corpus

With the above information, a data model is established to represent each entity (e.g. factory) and the types of materials, energy and wastes (Figure 2). This may include detailed information on production and ancillary materials required, type and amount of energy inputs, products, and co-products. On the waste streams, the entity shall cover, as appropriate, the sources and particulars of heat/stream emissions, solid waste, and liquid waste. On the operation aspect, the entity shall include business data, such as production volume, turnover, and address, etc. Overall, the attributes of the entity shall be sufficient to characterize the streams, such as amount, quantity, physical states and configuration, compatibilities, quality, etc. Such a representation provides an information model for the planning and analysis of industrial symbiosis networks.

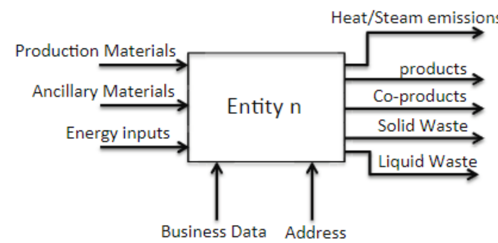

Figure 2. Entity flow modeling from data gathering and mining

4. Implementation Techiques

The next stage is the Eco-network Detection. At this stage, information of the entities and the associated flows of material, energy and waste are analyzed. Algorithms can be developed to search and enumerate all possible uses of the waste materials for each entity from the BDB. Figure 3. Identification of possible uses of a waste strea flow.

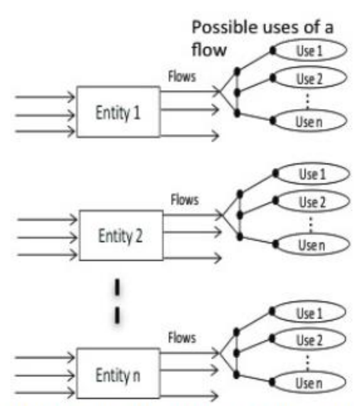

Figure 3. Identification of possible uses of a waste stream flow

5. Results

Of the eco-networks established, not all are technically and economically viable. Due to possible limitations in the accuracy and completeness of on-line data at the first stage, the technical viability may need detailed off-line investigations through further studies on the technical specifications, volume and quality of the waste materials from each entity. It is hence necessary to carry out an initial prioritization on the eco-networks. Two most important and technically feasible criteria for the prioritization are the volume and profit of the waste material in reference to the matched resource. Cut-off criteria can be established to shortlist the eco-networks for further information gathering from the actual entities (factories) identified in the shortlisted eco-networks for technical feasibility analysis. During the process, some networks may become unfeasible, and for the feasible ones, some entities (factories) may no longer qualify to be a party in the eco-networks. Based on the technically feasible eco-networks in the shortlist, an objective function can be established for network optimization. The possible objective functions would be to minimize the waste output of the system, maximize the value of recovered flows, minimise the environmental impact of the system, etc. The objective functions can be derived from the shortlisted eco-networks configurations, combined with process flow models, lifecycle assessment models and cash-flow models.

Examples of the objective functions may include:

- min {waste output}
- min {environmental impact}
- min {cost}
- max {value of recovered flows}
- max {return on investment}

6.C onclusion:

The projected expansion of large cities globally coupled with the increasing urban waste generation is a critical challenge. Industrial symbiosis is widely recognized as a desirable approach to not only minimize the waste, but also create value from the waste by using and conversion the waste into resources. Many successful cases have been reported in Europe and North America. These cases are either developed by some natural evolution, or by design. The increasing popularity of eco-industrial parks is a typical approach for the realization of industrial symbioses by design. Limitations in terms of the available land in large cities as well as the scale and diversity of companies in an eco-industrial park constrain the scale and effectiveness of the approach. Learning from past work and the authors' own experiences, a big data analytics approach is proposed. The aim is to realize industrial symbioses based on the existing establishments in a large city by leveraging on the big number and varieties of industrial/institutions. A study has been carried out to understand the ways and feasibility to develop industrial symbioses by such an approach. As a result, a framework and the feasible methods to develop a solution system is conceptualized and analyzed.

7. References:

[1] United Nations, World Urbanization Prospects: The 2014 Revision. Department of Economic and Social Affairs, United Nationa, New York 2014 (ISBN 978-92-1-151517-6).

[2] R. Dobbs, S. Smit, J. Remes, J. Manyika, C. Roxburgh, A. Restrepo, Urban World: Mapping the economic power of cities, . McKinsey Global Institute, March 2011.

[3] D. Hoornweg and P. Bhada-Tata, What A Waste: A Global Review of Solid Waste Management, World Bank, March 2012.

[4] Steffen Lehmann, Optimizing Urban Material Flows and Waste Streams in Urban Development through Principles of Zero Waste and Sustainable Consumption, Sustainability, 2011, 3, 155-183

Intergovernmental Panel on Climate Change [B. Metz, O.R, Davidson, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

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