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Zero waste approach towards a sustainable waste management

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ABSTRACT

On 30 June 2020, young scholars presented & discussed their work in a virtual forum, as a special session organized by The 15th International Conference on Waste Management and Technology (June 28–30), 2020 Beijing China. The forum convened researchers and attendees approaching innovative aspects of waste management from a variety of perspectives and disciplines. While their presentations spanned topics as broad as the stakeholder coordination and as specific technological approach for rapid carbonization of agricultural waste, several conceptual threads could be traced across them.

1. Increasing resource consumption inevitably results in waste generation

Cities around the world are expanding rapidly, taking up vast amounts of resources (e.g. construction materials, food, clean water, gas, oil, electricity) that feed their expanding economies. With cities being thermodynamic systems, an inevitable consequence of the relentless consumption of resources are waste materials, wastewater and polluted air (Tseng et al., 2020).

The technological innovations of the past did not decrease the rate of resource consumption, which raises the concern that improving efficiency might not be the ultimate solution to enable a good life for all within the planetary boundaries. Effective systems should be established to meet human needs, and then optimized for environmental efficiency (Hu et al., 2017).

2. Landfills and dumping are problematic, sub-optimal solutions to waste management

In the past, waste was perceived as a cost with landfilling as a typical management approach, but there has been growing recognition of its potential value. For example, In some Asian countries, most municipal solid waste (MSW) is openly dumped as it is the least expensive means of management. For example, an open dumping site at old Rajbandh, Khulna, Bangladesh was revealed that the potential risk to inhabitants in the vicinity associated with pollution of the soil, surface water, and groundwater from contaminated leachate and gasses (Fahmida and Rafizul, 2017; Pangkaj and Rafizul, 2019). The soil and water were found to be severely contaminated with heavy metals, posing risks via dermal contact and ingestion. Children are more vulnerable to the associated health risks (Pangkaj and Rafizul, 2019).

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Landfill waste management is a key challenge for policy makers and planners in the development of smart sustainable cities, due to their use of land and emissions to the surrounding environment. Existing landfills may help address growing global resource scarcity, serving as a resource reservoir available to be mined. Developing a framework for landfill mining requires an understanding on the quantity of waste and its characteristics. The application of systems engineering approaches equips regulatory bodies in planning, implementation, and monitoring activities associated with landfill mining projects. Identification of performance indicators equip city planners in waste systems planning, systematic monitoring, and decision making.

The use of innovative technologies, such as microwave pyrolysis, can overcome some challenging waste management issues and create co-benefits. For example, microwave treatment of crystalline silicon from waste solar panel cells can create a substitute for mined quartz sand. This approach can also recover significant level of copper from scrap printed circuit boards. Microwave treatment can rapidly carbonize waste agricultural straw which creates a material to enrich the soil; it provides an alternative to farmers burning the waste which causes combustion emissions.

3. Zero waste in cities is a useful frame, but requires an ambitious concerted effort

Realizing a Zero Waste city requires inputs and contributions from a number of different research fields and disciplines, including smart cities, urban resilience, green/smart mobility, the circular economy and complimentary, enabling undertakings such as the fab lab and makers movements. In Ireland, a lot of these disparate research strands have been woven together to support waste reduction, recycling and re-use — bringing us one step closer to the ideal goal of a zero waste city.

The concept of Zero Waste is an effective way to solve solid waste issues (https://enb.iisd.org/vol16/enb16153e.html). The approach is to inspire the reshaping of resource supply chain away from an outdated mode, so that entire products or by-product materials are reused or recycled. Achieving Zero Waste in urban centers remains a utopian quest, unless we gain a good understanding of the inputs and outputs, what remains as stock and for how long, and what leaks out of the system in the form of gaseous, solid, and liquid pollutants. Insight into the drivers, the dynamics and specific challenges related to materials, components and products, and transformation of those in the system is needed to help us make well targeted interventions that can help us minimize waste. Using the newly developed Complex Value Optimisation of Resource Recovery (CVORR) approach (Iacovidou et al., 2017) we are in better position to gain that systemic understanding of our resources and waste systems and gain an insight into the enabling conditions that reflect the challenges and trade-offs associated with sustainable management of resources and waste and their circularity potential.

4. Extending the life of products can reduce waste, but requires financial solutions

Creating products that are durable over a long time period can result in a reduction of waste, since fewer products are created and later disposed. The volume of waste reduction is roughly proportional to the lifespan extension. For instance, if a product lasts for 10 years rather than 1 year, then about 10 times less waste will generated. Planned obsolescence is a business strategy to intentionally create products that fail, in order to sell more replacements. There are many reasons why products become waste, including being designed for one-time use, product failure, becoming outdated, unfashionable, or technologically obsolete. Older product models often are less energy efficient than newer models; there tend to be overall environmental benefits from retiring energy inefficient products, but most products that do not consume energy during their use phase should have extended lives. The key challenges to implement this approach are financial. Manufacturing companies are invested in equipment to create massive volumes of short-lived products and would need to overhaul their business models to create fewer, durable products. Income-constrained consumers may prefer high-quality durable products but cannot afford the upfront cost. To overcome these challenges, manufacturers could be provided subsidies or low-interest loans to facilitate the overhaul. Consumers could be provided with affordable, long-term installment payment plans on par with the cost of the disposable products, which may need to be coupled with innovative credit options.

Resource effective systems should maintain the functionality of materials, components and products at the highest level possible over time (circular economy goal), with minimal efforts (resource effectiveness). A method that allows assessing resource effectiveness, including the maintenance and restoration of functionality on the material level (e.g. recycling), component level (e.g. reuse) and product level (e.g. lifetime extension), is multilevel Statistical Entropy Analysis (SEA). SEA allows to evaluate different combinations of CE strategies, identify critical system stages that lead to the most severe resource and functionality losses and thereby identify the most effective system (Parchomenko et al., 2020).

5. Coordinated effort needed across stakeholders, including consumers

The nature of circular systems requires a collective effort from all stakeholders in the product lifecycle including businesses, consumers, and governments. There is a potential for integrating lessons from behavioral sciences to design behavioral interventions in order improve e-waste management and thus promote a more circular economy (Parajuly et al., 2020).

Potential research in this direction may include (a) empirical understanding of factors governing consumer behavior in relation to circular economy such as e-waste disposal, reuse, repair behaviors, (b) systematic approach of designing, implementing, and testing behavioral interventions, and (c) integrating behavioral insights into local and national policy interventions as well as into the design of e-waste management infrastructure and business models to promote circular electronics.

There needs to be interaction among firms, consumers, policymakers, and researchers on enhanced reuse and recovery solutions toward a circular economy. Firms should be more responsible and develop new business models that transform gray substances into product variants rather than using virgin materials. Consumers can maximize separate collection of materials and opt for environmentally friendly actions. Researchers can support this green transition improving communication skills and providing quantitative analysis able to show the potential benefits.

To achieve the sustainable development goals (SDGs) (Liu et al., 2018) collective hard work among researchers, decision makers, along with local community are needed to execute innovative approach that help with alleviation of poverty and resource conservation.

6. Strategic policies and improved regulatory framework needed

The transition to a circular economy, where the multi-dimensional value of resources that spans the political, social, environmental, economic and technical domains is preserved in the techno-sphere, must be more supported by policies and operational decision-making based on evidence.

Policies toward material circularity simultaneously mitigate climate change, and therefore could be subsidized. National and international sustainable governance solutions need to recognize that contexts vary at the regional and local level, and therefore communities need to be involved the tailoring the solutions.

Waste containing persistent organic pollutants (POPs) is of special concern as they can bioaccumulate through food chain, have the potential for long-range transport, and pose risks to human health and the environment. An analysis of reported data shows that China has made great progress in the disposal of waste containing the 12 initial POPs, but still faces large challenges posed by waste containing the new POPs. There is a need to improve the regulatory framework, update POPs in the National Catalogue of Hazardous Waste, update the concentration limit for POPs in waste, and fill the data gaps of production volumes, their stockpiles and waste. Efforts are also needed to encourage the development and application of environmentally sound disposal methods and enhance public awareness.

The UNEA-4 theme of 'Innovative Solutions for Environmental Challenges and Sustainable Consumption & Production', and the resolutions addressed the following Issues: innovative solutions for environmental challenges and sustainable consumption & production; life-cycle management approaches to energy, resource efficiency, chemicals & waste; biodiversity loss & ecosystems damage and environmental governance; and innovative sustainable business development model during the time of rapid technological revolution (https://environmentassembly.unenvironment.org/unea4). In this context, "all researchers agreed that, the "Zero-Waste" concept is one of the promising and an effective way to solve the waste management & recycling issues. Zero waste approach is to inspire the reshape of resource supply chain, as a result that entire products or by-product (resource materials) can be reused & recycled, and the whole concept is the promotion to "UNEA4 resolution

This year ICWMT conference is hosted jointly by Tsinghua University (directly affiliated with the Ministry of Education of China), and Basel Convention Regional Centre (a global environmental agreement), that has undertaken significant efforts to set up a network of governments, academic circle, industrial sector, and other stakeholders at global level. In this context, the Young Scientist Forum a special session originally created in 2005 (Young Scholar Forum) to engage young researchers in the area of Waste Management & Technology. This year the forum entitled as "Young Scientist Forum" and, the theme of ICWMT is "2020 Global Waste Forum", and more particularly focus on the scientific opinion of young researchers "To Build a Zero-waste City Systematically". In my view point (Prof. Li Jinhui), this forum is one of the best scientific event for young researchers, the event organized every year by ICWMT and this time for the 15th time. The main objectives are to: provide platform to share scientific research and an understanding of global, regional and national situation of waste management; established a diverse global community of next-generation scientist and researchers, dedicated to engaging in collaborations associated to collectively identify waste management issues. This year the diversity of young speaker at the forum is amazing. In fact, the event itself started within the China, it has now extended globally. This year, there are 11 speakers participated from different countries in manner of wonderful science & technology and assessment work for waste management & technology research. So, as Chairman of this international conference "I believe all young researchers need to work together in the form of scientific consortium, where young researchers can meet time to time at virtual platform to discuss the global waste management issues, and importantly I would like to suggest, please more active at the global platform, to exchange idea, share knowledge & research, learn from each other, and we also inviting other young researchers worldwide to join us and together work for solving the waste management issue

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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