In: Contaminants in Agriculture and Environment: Health Risks and Remediation
DOI: 10.26832/AESA-2019-CAE-0167-015

Chapter 15
Strategic framework and phenomenon of zero waste for sustainable future

Syed Rouhullah Ali* **and Rohitashw Kumar**

Chapter contents

Introduction 201
The key features for the development of zero waste strategy 202
Global waste issues and cities: why zero waste? 203
The development of zero waste concept 207
Zero waste initiative in the world 210
Conclusion 210
References 211

Abstract

The idealistic concept of zero waste promotes a systematic procedure of waste planning and recovery of resources from waste. The Zero waste concept is to minimize waste production so as to reduce waste in the landfill. A strategic zero waste framework (ZWF) is essential for the development and achievement of systematic waste management activities in order to achieve general objectives. The developing phenomenon of zero waste includes the theory, practice and learning of characters, families, businesses, communities and government organizations, responding to the perceptions of crisis and failures around conventional waste management. Furthermore, a constant assessment of progress towards zero waste targets is essential. It is expected that, taking into account local circumstances, the proposed strategic guidelines would be beneficial for local authorities and stakeholders, while developing their zero-rejection strategy. Waste management from the beginning of waste disposal, waste sorting, producer responsibility and waste collection based on the quantity of waste, community waste management and the provision of incentives and disincentives is the zero waste implementation parameter. This concept should be assimilated into local policy so it becomes an obligation for the government

Syed Rouhullah Ali , Email: agasyedrouhullah@gmail.com

Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar campus, Srinagar-190025, J&K, INDIA

and the community to implement it. A number of cities around the world have implemented zero waste policies and set a goal to reduce waste disposal to tonnes per annum (TPA) as small as possible.

Keywords: Landfills, Recycling, Resource conservation, Waste, Waste management, Zero waste

Introduction

Waste is one of the main world ecociders. Indeed, the waste meets all the standards of an ecocide; it causes the destruction of the environment, damages ecosystems, impends any kind of life and pays no attention to the rights of future generations. Waste is the living proof of the degree of self -centeredness and stupidity of the most intellectual generation of human beings this planet has seen. Nature creates no waste; it is a genuine human creation. In nature nothing and nobody goes to waste because the definition of an ecosystem is a system of cooperative and symbiotic relationships; the discards of a process are the input for another one. Everything is up-cycled into the system so that the system is sustainable and resilient. In an ecosystem all energy used is renewable and non-polluting and all resources are obtained in the vicinity using non-extractive, low-energy-intensive techniques. Processes take place at normal local temperatures and pressures and combustion is not an option. The current linear passing society is the opposite of sustainability; resources are extracted, transported, manufactured, sold, used and discarded, committing ecocide at almost each and every stage of the process.

Zero waste (ZW) is one of the most studied topics, but the most discussed disadvantage of waste management research in recent years (Greyson, 2007; Seltenrich, 2013; Zaman 2015; LaBrecque, 2015). Zero Waste is defined as "systematically designing and managing products and processes to eradicate waste and materials, conserve and recover all resources and not burn or bury them" (ZWIA, 2004). Thus, Zero Waste is about waste deterrence through sustainable design and consumption practices, optimum resource recovery from waste and not about managing waste by incineration or landfills (Zaman and Lehmann, 2011). It is comprehensible that Zero Waste strongly supports waste prevention and deterrence approaches rather than waste treatment and disposal. However, it may not be possible to accomplish zero landfill and zero incineration objectives under the current system of resource consumption and waste management practices.

Waste has been treated as a burden and social problem and thus largely managed by “end-of-pipe” solutions such as landfill (Zaman, 2015). With few exceptions in the developed countries in Europe, North America and Asia-Pacific, the traditional waste management system, which primarily relies on landfill, significantly pollutes our environment, and thus an enhanced and effective waste management system is required. This study starts from the position that waste is not an “end-of-life” problem alone, but rather waste is an intermediate stage in the conversion of resources that occurs in the consumption process. The resources that are transformed into “waste” thus need to be readdressed in the production process through holistic Zero Waste

management systems. In addition, waste is a social problem and it entails social technologies to solve it. Hence the goal of zero waste is to consume and utilize resources within a circular economic model, with least environmental deficiency using industrialized symbiosis, recycling or "up cycling", centered on nature's "no-waste" belief (Zaman, 2015).

Strategic waste management policies are commonly used by local governments and business organizations for managing waste problems (USEPA, 2013). A strategic framework for waste management is essential for the successful execution of a waste management plan as it forms the basis of an effective planning procedure (King, 2004). A number of studies have been conducted on the development of waste management frameworks (Gillwald *et al*., 2013; Lu and Yuan, 2011), including decision frameworks (Ramesh and Kodali, 2012), legislative frameworks (Sentime, 2014) and hierarchical frameworks (Liao and Chiu, 2011). A facility helps decision makers comprehend, improve, evaluate and guide waste management systems. This study aims to ascertain the key guiding principles that help to develop a strategic zero waste framework. The purpose of the zero waste strategic framework is to guide waste management policy and decision makers while developing and proposing waste management strategies and policies.

The key features for the development of zero waste strategy

Many local councils set their zero waste goals to "alteration of waste from landfill"; however, alteration of waste alone may not be sufficient as it requires inventive design and sustainable consumption to accomplish the long-term goals. The 3R principles (reduction, re-use and recycling) are among the top three in the waste hierarchy and they are considered as the establishing principles of sustainable waste management system (Hansen, 2002). The "3R" principles in the European Union Waste Framework Directive 2008, have been extended to five steps of the waste hierarchy: prevention, re-use, recycling, recovery (including energy retrieval), and disposal (European Commission, 2012).

A number of approaches have been acknowledged in various studies such as eco-design, responsible shopping behavior, etc., in relation to waste prevention and anticipation (Braungart *et al*., 2007; Schmidt, 2012). Waste prevention is one of the most important concerns in zero waste and it requires collective social awareness and knowledge on waste and ingenious manufacturing and business models (Cox *et al*., 2010). Attentiveness awareness and transformative knowledge are often understood to motivate behavior change in relation to pro-environmental lifestyle choice (Jackson, 2005).

Responsible and sustainable consumer behavior is another significant issue in waste prevention. Collaborative consumption increases efficacy in resource consumption and improves social collaboration (Rogers and Botsman, 2010). The collaborative ownership or collaborative consumption model encourages service-based business and waste prevention (D-Waste, 2013). Therefore, re-circulation (circulate the materials in the supply chain for a repetitive use) of post-consumer products through re-use and re-sell is essential and it boosts the circular economy

and enhances social capital.

Waste management and treatment technologies are used in resolving waste problems for more than centuries (UNEP/GRID, 2006). Zero waste takes the position that technology alone cannot solve the waste evils sustainably, as it requires community participation, service infrastructure, regulatory policy and eco-friendly treatment technology. A number of studies have acknowledged that effective collection systems, decentralized waste recycling centers, social technology such as recycling, composting, regulatory policies such as pay-as-you-throw (PAYT) and eco-friendly advanced waste treatment technologies are the vital issues performance evaluation is an integral part of a strategic framework to govern the impending direction of waste management systems. Moreover, accurate and reliable data on waste management systems is absolutely important to assess and monitor the overall performance of the waste management systems is entirely important to assess and observe the overall performance of the waste management strategies and programmers. Zero waste research in relation to data analysis, foretelling waste strategies and programmers. Zero waste research in relation to data analysis, forecasting waste generation and management developments and continuous expansion in waste prevention and avoidance and techniques (DE, 2013).

Global waste issues and cities: why zero waste?

Resources from all over the biosphere are described as being, "funneled" into the world's cities to meet the expanding consumption, driven by hastening globalization, urbanization, and affluence (Girardet, 2000; Krzeminska *et al.*, 2017). A commonly cited metric illustrating the associated imbalance and exploitation is that cities occupy just two per cent of the earth's land surface, yet use over 75 per cent of its resources and discharge corresponding proportions of waste (Girardet, 2000). Similarly, urban societies currently account for over 70 per cent of global energy-related CO_2 emissions (Edenhofer *et al.*, 2014). The cities that extrapolate this more interconnected exploitation-discharge seem to be the upper part of the "anthroposphere", which Manahan enunciates as centrally implanted in a rubric of material, energy and waste altercation within the dynamic interaction of atmosphere, biosphere hydrosphere, and geosphere (Manahan, 1999). Such reporting draws a unambiguous distinction between the extractive, carbon intensive, lineal, disposal orientated human systems, and the "biological analogy" (Ayres and Ayres, 2002) and "ecosystem" design metaphor (Korhonen, 2004; Isenmann, 2008) offered in, what are popularly inferred as the infinitely sustainable, solar powered, zero emissions, circular metabolism of natural systems (Lehmann, 2010; Lehmann, 2011). The functionality of urban systems is said to govern whether the waste outputs of cities, discharge to atmosphere, or gets deposited in dumps/landfills, or unintentionally/deliberately litters the landscape, before accumulating in rivers and the ocean (Zaman and Lehmann, 2011; Hoornweg *et al.*, 2015). In respect of a lot of sustainably managing the universally significant urban resource/waste stocks, flows, and sinks, the development of sustainable future cities is cited as demanding a regenerative design mind-set

and fostering new technical and organizational solutions, which bio-mimic nature's inherently successful—circular design (Benyus, 1997; Garcia-Serna *et al* 2007; McDonough and Braungart, 2010). Striving for zero-carbon transport, energy and building systems (i.e., "nZEB") (Riffat *et al*., 2016), resource preservation and efficiency, and the beneficial recycling and reabsorbing non-toxic non-polluting water (Verstraete and Vlaeminck, 2011) and waste flows, as a resource (hence improving quality of life and the long-term environmental sustainability of the whole system) are identified as critical challenges within future city discourse (Verstraete and Vlaeminck, 2011; Mezher, 2011; Porse, 2013). Zero waste (inclusive of future zero waste city models) has been described as a pathway being "forged" towards a desirable long-term goal (Bartl, 2011) and in some sectors almost achieved (Mezher, 2011). However, zero waste is also regarded negatively by some, as a potentially harmful myth (Premalatha *et al*., 2013). Notwithstanding this spectrum of reporting, a range of integrated green urban design principles, such as sustainable design and circular urban metabolisms, have been discussed as being central to realising the concept of a zero waste city (Lehmann, 2010; Lehmann, 2011). Given the conflicting assertions that the phenomenon of zero waste affords a critical opportunity to address waste issues (Zaman and Swapan, 2016), a starting point in exploring these claims, is to scrutinize current global "progress to date" in managing waste. A cluster of international reports describe the issues that are associated with waste, as of becoming a globalised public and environmental health emergency, necessitating an urgent, internationally coordinated, comprehensive, and effective response (Mavropoulos and Newman, 2015; Mavropoulos *et al*., 2017). The environmental and social consequence of humanities failure to effectively manage waste, has resulted in some of the most polluted and poverty stricken places on Earth (Mavropoulos *et al*., 2017). Whilst this syndrome is often localised and most concentrated around (mega) cities (UN-Habitat, 2010; Mavropoulos, 2010; Guerrero *et al*., 2012), the interrelated aquatic and atmospheric dimensions of impacts of terrestrially generated waste is now being registered across the entire global biosphere (Ryan *et al*., 2009; Moore, 2008; Hodzic *et al*., 2012; Wiedinmyer *et al*., 2014; Thompson, 2014). The World Bank reported that, the 2012 baseline of 1.3 billion tons of municipal solid waste (MSW) generated by cities globally, is projected to double by 2025 to 2.2 billion tones pa (Hoornweg and Bhada-Tata, 2012). The current trajectory of growing population, urbanization and consumer demand, underwrite such projections (Troschinetz and Mihelcic, 2009; Mavropoulos, 2010; Mavropoulos, 2011). Given this, it appears unlikely that the vital challenge of reducing waste generation (i.e., located as the highest priority of the"5R" waste hierarchy (i.e. firstly: reduce, reuse, recycle, recover energy and then lastly residual disposal)) is, under "business as usual" conditions, immediately achievable. Concerning, it has been reported that, unless aggressive sustainability scenarios are successfully implemented, "global peak waste" might not occur until 2100 (Hoornweg *et al*., 2015; Serpe *et al*., 2015). Increasingly, the interconnected dimensions of the waste issue, (i.e., ocean plastics, disaster waste management, chemical toxicity and dissipation, food-waste, organized crime, nuclear waste, and emerging "NBRIC" (i.e. nanotechnologies, bio-technologies, information and communication technologies (i.e. WEEE), robotics and cognitive

sciences (Graedel and Allenby, 2010) is attracting media reporting and a correlated escalation in public awareness and alarm. This extent and assortment of waste issues, is overlain by systemic causalities, such as history, geography, infrastructure and technology, entrusted interests and ideology i.e., privatisation (Iskandar and Tjell, 2009), and individual and collective cultural and socio-economic imperatives, which adds to associations of "super wicked" complexity and inflexibility.

In terms of the global provision of "residual disposal" (i.e., the supposed least priority, at the bottom of the 5R waste hierarchy) the efficacy and outcome to date of the conventional waste management paradigm and practice, also raises questions. The International Solid Waste Association's (ISWA)—"Global Waste Management Outlook" (GWMO) bring into line with other similar reporting, in estimating that, between 2 and 3 billion people live below the most basic waste management system benchmarks of collection and controlled disposal (Zero Waste South Australia, 2013; Wilson *et al*., 2015). Aggravating apprehensions around the pollution and climate change impacts of systemic failings in global waste management, reporting indicates that the default disposal "treatment" for approximately 41% of global waste is uncontrolled burning (Wiedinmyer *et al*., 2014; Thompson, 2014). The critically important global ISWA program seeking to rectify this syndrome (Mavropoulos *et al*., 2017) has set challenging goals (i.e. "As an preliminary step, aim to: accomplish 100% collection coverage in all cities with a population more than 1 million, eliminate open burning of municipal solid wastes, similar wastes and turn them into controlled launching" (Wilson, 2015). Achieving these goals characterizes a key initial benchmark in modern "integrated solid waste management" (UNEP, 2009; ISWA, 2003; Zeng *et al*., 2010). However, it is important to recognize that achieving those baselines, is just the starting point for the intended transition to holistic, sustainable resource conservation, and material circularity, which advocated in, for example, "circular integrated waste management systems" (CIWMS), zero waste and a circular economy discourse (Zaman and Lehmann, 2011). Whilst it can be accepted that "the world can't recycle its way out of waste" (Mace and Szaky, 2016). Equally, the common scientific oratory offered by the USEPA (USEPA, 2013) underwrites the growing ubiquity and popularity of recycling today. Keynote environmental commentators correspondingly link the benefit of recycling to the challenge of addressing climate change. Stern argues that, because recycling makes such foremost and under-appreciated contributions to reducing GHG emissions it is one of the "best kept secrets in energy and climate change" policy (Stern, 2009). Such glowing assessments has been more recently "reality checked" by China's successive "Green Fence", "National Sword", and "Blue Sky" import policies applying to recycled materials, which has sent repercussions through global recycling markets (WasteMINZ, 2018). Overall, the importance and positive opportunity of "recycling citizenship" confirmed by the informal sector and communities across the global spectrum of socio-economic development, is now well recognized (Seyfang, 2005; Silva *et al*., 2017).

However, in spite of the significant environmental and social opportunities that are ascribed to recycling, it is estimated that globally, currently only one-quarter to a third of the total 3.4–4

billion tons of MSW and industrial waste produced annually, is recycled (D-Waste, 2013). So in summary, international waste data designates that, after over four decades of significantly investing in the widely established principles of the "waste hierarchy", there are still significant barriers in realizing the stated: top (reduce), middle (recycle), or even lowest (residual disposal) priorities. Whilst conventional waste management theory, concentrated into the near universal rubric of the waste hierarchy, clarifies our priorities and can be seen as having catalyzed a measure of development, overall we are yet to globally actual is e this principle and appear to be "entangled/trapped" in limitations of this paradigm (Bartl, 2014; Van and Stegemann, 2016; Pollans, 2017). The net result is that, most of these sources which flow through the global economy still shipment via the destructive and polluting linear model, variously described as—"take-make-waste"(Jessen, 2003)/"dispose" (Ellen, 2013). Evidencing this, socio-metabolic research, which assessed the degree of circularity of resources flowing through the global economy, describes this as currently, only in the early phases (Haas *et al*., 2015; Ghisellini *et al*., 2016). Currently, the progress of a more "circular economy "is limited by a rapid growth in "socio economic stocks", a focus on recycling rather than reuse/reduction and an estimated 44% of processed materials that are incinerated to "provide energy"(Haas *et al*., 2015), and hence, exit rather realize economic circularity. The zero waste movement (Anderson, 2011) can be regarded as one of a cluster of sustainability actors, which both highlight and respond to the link of failure, inertia, and growing sense of crisis, which is associated with the conventional waste management paradigm (Hannon, 2015). The zero waste movement comprehends a range of perspectives and approaches and can be regarded as a neologism, residing in a busy "eco-ideas marketplace", alongside interrelated and complementary theses on how sustainable development can be engineered (Glavic and Lukman, 2007). For instance, whilst disciplines, such as industrial ecology (IE), urban metabolism (UM), and bio economy (BE), and the activities for a "circular economy" (CE) and zero waste each arise out of differing: perspectives, personalities, and intellectual traditions, the appearance of shared cognitive DNA seems clear (Veleva *et al*., 2017). These movements are conceptually aligned and complimentary in seeking to confront and re-design and replace the existing "exploitative", lineal economic model with progressively more cyclical and sustainable resource management, where anthropogenic systems "bio-mimic" the modelling of natural systems (Hawken *et al*., 1999). However, in this sphere, zero waste also has a unique identity and assumes a distinctive role, expressed in the broadly accepted, peer-reviewed definition offered by the Zero Waste International Alliance (ZWIA, 2004; ZWIA, 2009). In the adoption of confrontational terminology, a campaign posture and in advocating for a hyper-aspirational continuum of innovation, zero waste seeks to confront the perceptions of normalcy and intractability around waste. The embrace of dissent and involvement in the framing of zero waste, together with the embrace of community/NGO involvement and the economically redistributive aspects, is why the movement is simultaneously controversial, and arguably indispensable (Lombardi and Bailey, 2015).

Encompassed in the prickly opposition to incineration and landfill, zero waste pursues to refute

and disrupt the predominant normalization of waste and our "throw-away society, as a relatively recent socio-economic construction, which can and must, be redesigned (Herbert, 1998; Waste Watch UK, 2004). Zero waste directly challenges the waste management industry's twin bury and burn profit centers, on the basis that disseminating our "flame, flush or fling" (Seadon, 2010) disposal mentality, ultimately binds human society to linear material flows, rather than enables the growth of a more circular economy. Rather than admiring the supposed technical progress of reforming disposal systems (such as sanitizing, or optimizing landfill or extracting energy from incineration) zero waste regards these "developments" as confirmation of societal capture to a failing and unsustainable socio-economic model (Seadon, 2010; Connett, 2013; Lombardi and Bailey, 2015). The dissatisfied global progress toward genuinely sustainable material resource management is the central provocation catalyzing the global search for alternative modes for generating innovation and development. Within this spectrum of activity, a growing regiment of organizations and practitioners choose to self-identify, under the heterogeneous brand of zero waste.

The development of zero waste concept

Eliminating waste from production process to costumer usage is a waste minimization strategy (Zero Waste SA Strategy, 2010). Waste is more often observed as useless goods by society and even industry. This is actually a deceitful view if humans understand and comprehend how waste has a price and can also harm environment. A global understanding has appeared, widely accepting the effects of climate change, including loss of biodiversity, increased air pollution, soil and water, deforestation and reduced resources and materials, as a consequence of disproportionate consumption of unsustainable production processes. About 20% of the waste can be recycled or recovered annually where the world's waste engenders four billion metric (Chalmin and Gaillochet, 2009). Increased waste generation is produced by linear material flow rate system where the waste ends in the landfill. In present time the world is more run a linear economic system where the product will end up just like that in the landfill. While the concept of zero waste (ZW) is the contrary of linear circular system is the flow rate of material is a circular system where the end of the product becomes the beginning of another product as well (nothing is wasted). Figure 15.1 shows the comparison of the material flow rate between linear and circular systems.

(Palmer, 2004) was the first to use the term Zero Waste in 1973 as a term to recover resources from chemical waste. A number of cities in the world in 1995 implemented No Waste legislation to achieve the 2010 targets and Canberra became the first city in the world to successively and effectively achieve Zero Waste targets (Snow and Dickinson, 2003; Connett, 2013). The advent of Zero Waste regulations in New Zealand in 1997 supported the initiative to minimize waste through the Zero Waste movement in the country. This movement voiced thorough "closed loop material economy system in which a product is made for reuse, repair and recycling, an economic

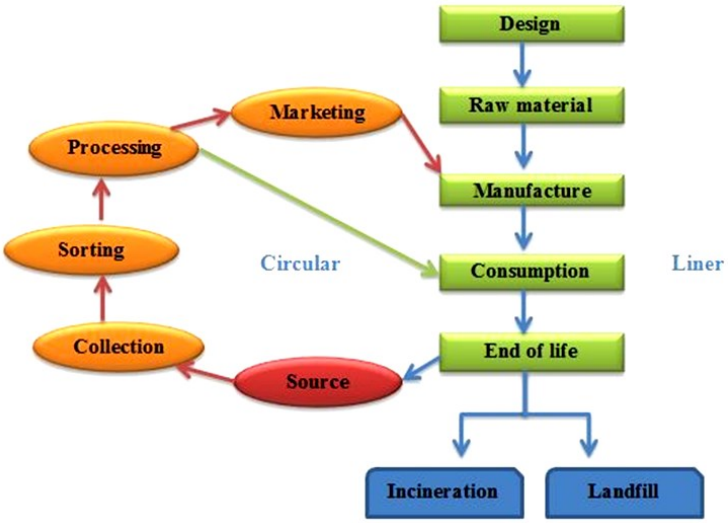

Figure 15.1. *Flow rate of material through circular (zero waste) and linear systems (Song et al., 2015).*

Table 15.1. *Achievements and events related to zero waste.*

Year	Country	Milestone/event
1970s	USA	The term 'Zero Waste' was introduced by Paul Palmer
1986	USA	The National Coalition against Mass Burn Incineration was formed
1988	USA	Seattle presented the Pay-As-You-Throw (PAYT)
1989	USA	The California Integrated Waste Management Act was passed to accomplish the 25% target of waste diversification from landfills in 1995 and 50% in 2000
1990	Sweden	Thomas Lindhqvist presented 'Extended Producer Responsibility.
1995	Australia	Canberra passes Act No Waste by 2010
1997	New Zealand	The Zero Waste New Zealand Trust was established
1997	USA	The California Resource Recovery Association (CRRA) held a Zero Waste conference
1998	USA	Zero Waste is encompassed as a key principle of waste management in North Carolina, Seattle, Washington, & Washington DC
1999	USA	CRAA conducted a Zero Waste conference in San Francisco
2000	USA	The Global Alliance for Incinerator Alternatives was formed
2001	USA	Grass Roots Recycling Network published 'A Citizen's Agenda for Zero Waste.'
2002	New Zealand	The Cradle-to-Cradle book was published
2002	USA	Zero Waste International Alliance (ZWIA) was formed The first Zero Waste Summit was held in New Zealand
2004	USA	ZWIA defines Zero Waste GRRN adopts Zero Waste business principles
2004	Australia	Zero Waste SA was established in South Australia
2008	USA	The Sierra Club adopted the Zero Waste producer responsibility policy
2012	USA	The documentary Trashed premiered at the Cannes film festival The Zero Waste Business Council was founded in the United States.

system that reduces and ultimately closed circle of the economy; one in which products are made for reuse, repair and recycling, economies that minimize and ultimately eliminate waste" (Tennant, 2003). In 2000, Del Norte County, California became the first state in the USA to implement a inclusive Zero Waste plan and in 2001, the California Integrated Waste Management Board adopted the Zero Waste goal as a strategic waste management plan (Connett, 2013). Achievements, accomplishments and events related to Zero Waste development can be seen in Table 15.1. Applying zero waste means eradicating all disposals in soil, water or air which is a threat to the planet, human health, animals or plants (ZWIA, 2004).

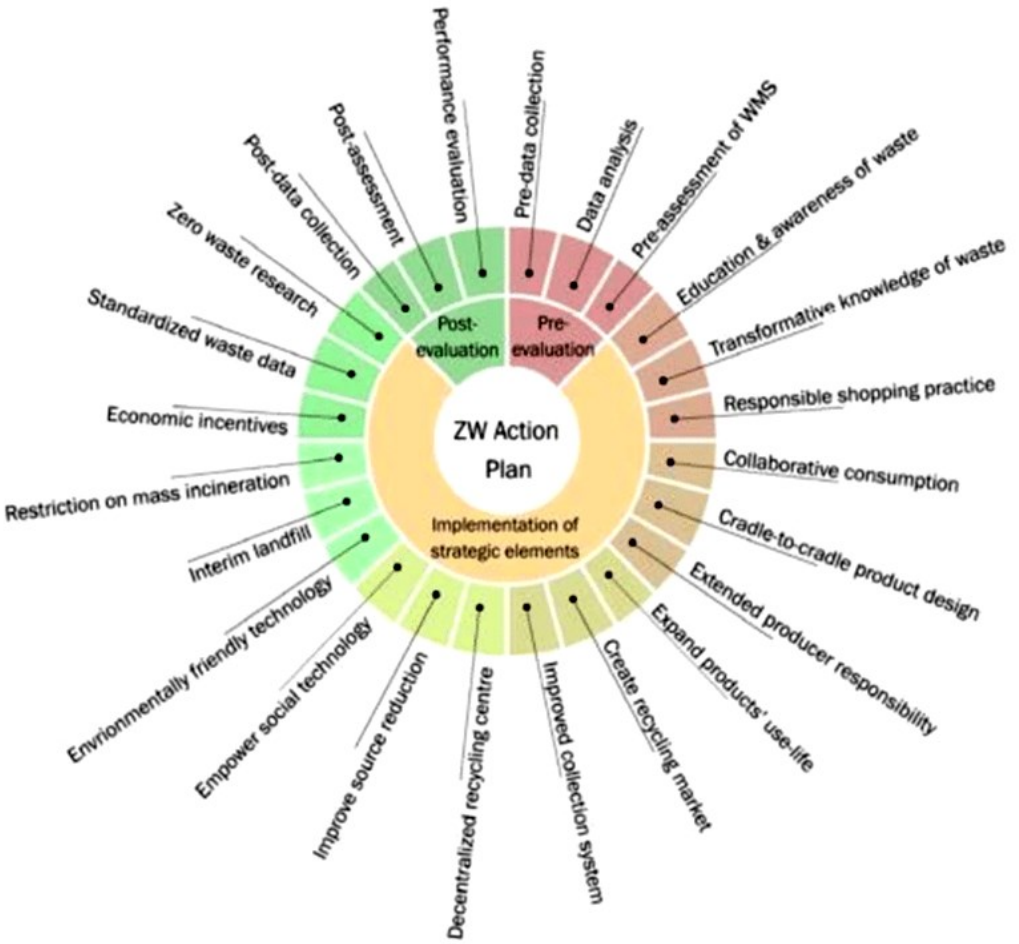

Figure 15.2. *Steps to implement the zero waste action plan (Source: Zaman, 2017).*

Eradicating incinerators, landfills, throwaway societies and creating communities that manage sustainable waste are ideals of zero waste. Zero waste implementation cannot be predictable to run in short time or for example within a year, but we can plan a situation that is very close to zero waste in the next five or ten years (Connett, 2007). Disproportionate exploitation causes the natural resources to become increasingly limited in number, creating ambiguous future development. This should be prevented, therefore humans should involve in sustainable consumption and waste management strategies based on (1) waste avoidance, (2) material efficacy and (3) restoration of resources (Lehmann, 2011). The zero waste concept continues to grow, not stopping just as recycled but also restructuring the product design to avert the issue of waste in the early stages (Tennant, 2003). Figure 15.2 shows the steps that can be done if the city implements zero waste well then the city can be bowed into a city of zero waste.

Zero waste initiative in the world

Canberra became the first city in the world to endorse zero waste laws in 1996. In 2004, the city of Canberra has grasped 70% of waste diversification. One of Canberra's programs is to establish a place called "Resource Recovery Park" to help industry creates products from separate materials and they can market reusable materials. Adelaide, a city in South Australia has established and implemented a zero waste strategy. The waste composting program is increasing expressively and they are targeting by 2015, the compost capacity must be higher than the waste sent to the landfills. The city has a high percentage of waste diversification, reaching 82%. Stockholm is one of Europe's leading cities and environmental standards are very high and have ambitions to improve the quality of the environment. Stockholm has already instigated its goal of being a fossil -free city in 2050 (Stockholm City, 2009). One of the key goals of this 2030 vision is to alter Stockholm city into a resource-efficient area (RUFS, 2010). The city of Halifax-Nova Scotia, Canada reaches 60% of the rate of waste diversification. The Zero Waste program creates 1000 jobs in garbage collection and processing. In addition 2000 jobs were created in the sector of used goods collection industry. Almost all separately-used goods are reused by industry in Nova Scotia (Dahlen and Lagerkvist, 2010). The most progressive city is San Francisco, with a population of 850.000, has reached 77% of waste diversification, the highest in the United States, with a three-pronged approach: implementing strict waste reduction laws, partnering with waste management companies to innovate new programs, and work to create a culture of recycling and composting through enticements and working with communities. San Francisco endeavors to adopt the Zero Waste goal to be achieved by 2020 (Zaman and Lehman, 2013).

Conclusion

A strategic zero waste framework is indispensible for initiating major activities to achieve zero waste goals. This study tried to ascertain the key guiding principles for the development of a

strategic zero waste framework based on a unanimity analysis of waste experts. The key elements of the zero waste framework are acknowledged by the literature focusing on waste prevention and circumvention, waste management and treatment, and monitoring and assessment. The expert survey identified eighteen strategic elements as important guiding principles for the development of a holistic zero waste framework. The study acknowledged that all the strategic elements may not be possible in all countries, especially in the developing countries where appropriate infrastructure and governing policies are not available and for developed countries where secondary waste management costs are very high. A further study can be conducted to identify and explain the elements that are appropriate for different economic frameworks (developed and developing). It is expected that by considering the local circumstances such as local waste management priorities, waste market and economic condition, the proposed elements would work as directorial principles for achieving the zero waste goals. The fundamental transformation of existing systems is prerequisite and the study concluded that the zero waste goals may not be accomplished without a closed-loop production system in place, wide application of liable consumption practices, conservative waste management systems and continuous development through monitoring and assessment of waste management performance. The conclusions of this study are important and can underwrite to the knowledge of zero waste management. Therefore, it would be beneficial for local establishments to consider the proposed strategic elements while developing local and national zero waste strategies. Zero Waste can be an alternative concept in waste management because zero waste is a concept that starts from, prevents waste in "upstream" to "downstream", not just control waste by dumping it to landfill. Require the association of all parties in implementing the concept of zero waste, ranging from private parties, governments and communities in the execution of this concept. Policy support from the national government in the form of a stable regulation is required for zero waste to be implemented properly.

References

Anderson, C. (2011). Dealing with zero waste; MSW Management: Santa Barbara, CA, USA, pp. 1–5.

Ayres, R.U. and Ayres, L.W. (2002). A handbook of industrial ecology Edward Elgar. Cheltenham (UK), pp. 680.

Bartl, A. (2011). Barriers towards achieving a zero waste society. *Waste Management*, 12(31): 2369-2370.

Bartl, A. (2014). Ways and entanglements of the waste hierarchy. *Waste Management*, 34(1): 1-2.

Benyus, J.M. (1997). Biomimicry: Innovation inspired by nature; Harper Collins Publishers Inc. New York, NY, USA.

Braungart, M., McDonough, W. and Bollinger, A. (2007). Cradle-to-cradle design: creating healthy emissions–a strategy for eco-effective product and system design. *Journal of Cleaner Production*, 15(13-14): 1337-1348.

Chalmin, P. and Gaillochet, C. (2009). From waste to resource, an abstract of world waste survey. Cyclope, Veolia Environmental Services, Edition Economica, France.

Connett, P. (2007). Zero Waste: A Key Move towards a Sustainable Society. American Health Studies Project.

Connett, P. (2013). The zero waste solution: untrashing the planet one community at a time. Chelsea Green Publishing: White River Junction, VT, USA.

Cox, J., Giorgi, S., Sharp, V., Strange, K., Wilson, D.C. and Blakey, N. (2010). Household waste prevention—a review of evidence. *Waste Management & Research*, 28(3): 193-219.

Dahlen, L. and Lagerkvist, A. (2010). Pay as you throw: strengths and weaknesses of weight-based billing in household waste collection systems in Sweden. *Waste Management*, 30(1): 23-31.

DE (2013). Department for Environment, Food and Rural Affairs. Consultation on the Waste Prevention Programme for England.

D-Waste (2013). Waste Management for Everyone.

Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K. and Kriemann, B. (2014). Contribution of working group iii to the fifth assessment report of the intergovernmental panel on climate change. *Climate Change*. 1-11.

Ellen, M. (2013). Towards the Circular Economy 1: Economic and business rationale for an accelerated transition. Ellen MacArthur Foundation: Cowes, UK.

European Commission (2012). Preparing a Waste Prevention Programme: Guidance Document; European Commission: Paris, France.

Garcia-Serna, J., Perez-Barrigon, L. and Cocero, M.J. (2007). New trends for design towards sustainability in chemical engineering: Green engineering. *Chemical Engineering Journal*, 133(1-3): 7-30.

Ghisellini, P., Cialani, C. and Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, 114: 11-32.

Gillwald, A., Tocho, J.A. and Waema, T.M. (2013). Towards an e-waste management framework in Kenya. *Info*, 15: 99-113.

Girardet, H. (2000). Cities people planet. In Urban Sustainability Schumacher Lectures; Wiley: Liverpool, UK.

Glavic, P. and Lukman, R. (2007). Review of sustainability terms and their definitions. *Journal of Cleaner Production*, 15(18): 1875-1885.

Graedel, T.E. and Allenby, B.R. (2010). Pearson Education Inc., Upper Saddle River, Prentice Hall. Industrial Ecology and Sustainable Engineering: International Edition, pp. 425.

Greyson, J. (2007). An economic instrument for zero waste, economic growth and sustainability. *Journal of Cleaner Production*, 15(13-14): 1382-1390.

Guerrero, L.A., Maas, G. and Hogland, W. (2013). Solid waste management challenges for cities in developing countries. *Waste Management*, 33(1): 220-232.

Haas, W., Krausmann, F., Wiedenhofer, D. and Heinz, M. (2015). How circular is the global economy?: An assessment of material flows, waste production, and recycling in the European Union and the world in 2005. *Journal of Industrial Ecology*, 19(5): 765-777.

Hannon, J. (2015). Waste vs. zero waste: The contest for engaging and shaping our ambient 'waste-making'culture. Unmaking Waste.

Hansen, W., Christopher, M. and Verbuecheln, M. (2002). EU waste policy and challenges for regional and local authorities. Ecological Institute for International and European Environmental Policy: Berlin, Germany.

Hawken, P., Lovins, A.B. and Lovins, H. (1999). Natural Capitalism: Creating the Next Industrial Revolution; Little Brown and Co.: Boston, MA, USA, pp. 396.

Herbert, L. (1998). The Institute of Wastes Management this week celebrates its 100th birthday in Manchester, where it all began in 1898. Surveyor-Sutton then London, pp. 18-19.

Hodzic, A., Wiedinmyer, C., Salcedo, D. and Jimenez, J.L. (2012). Impact of trash burning on air quality in Mexico City. *Environmental Science & Technology*, 46(9): 4950-4957.

Hoornweg, D. and Bhada-Tata, P. (2012). What a waste: a global review of solid waste management. World Bank, Washington, DC, pp. 116.

Hoornweg, D., Bhada-Tata, P. and Kennedy, C. (2015). Peak waste: When is it likely to occur? *Journal of Industrial Ecology*, 19 (1): 117-128.

Isenmann, R. (2008). Further efforts to clarify industrial ecology's hidden philosophy of nature. *Journal of Industrial Ecology*, 6(3 -4): 27-48.

Iskandar, L. and Tjell, J. C. (2009). Cairo: a colossal case of waste mismanagement to learn from. *Waste Management Research,* 27: 939–940.

ISWA (2003). ABRELPE. Solid Waste: Guidelines for Successful Planning; ISWA & ABRELPE: Sao Paulo, Brazil.

Jackson, T. (2005). Motivating sustainable consumption: A review of evidence on consumer behaviour and behavioural change. *Sustainable Development Research Network*, 29: 30.

Jessen, M. (2003). Discarding The Idea of Waste: The need for a zero waste policy now. Zero Waste Services: Nelson, BC, Canada.

King, S. (2004). Strategic Framework-the foundation of an effective planning process.

Korhonen, J. (2004). Industrial ecology in the strategic sustainable development model: strategic applications of industrial ecology. *Journal of Cleaner Production*, 12(8-10): 809-823.

Krzeminska, A.E., Zaręba, A.D., Dzikowska, A. and Jarosz, K. R. (2017). Cities of the future-Bionic systems of new urban environment. *Environmental Science and Pollution Research*, 1-9.

LaBrecque, S. (2015). Talkpoint: What does zero waste mean to you? In The Guardian; the Guardian: Manchester, UK.

Lehmann, S. (2010). Resource recovery and materials flow in the city: Zero waste and sustainable consumption as paradigms in urban development. *Sustainable Development Law & Policy*, 11: 28-68.

Lehmann, S. (2011). Optimizing urban material flows and waste streams in urban development through principles of zero waste and sustainable consumption. *Sustainability*, 3(1): 155-183.

Lehmann, S. (2011). Resource recovery and materials flow in the city: Zero waste and sustainable consumption as paradigms in urban development. *Sustainable Development Law & Policy*, 11(1): 13.

Liao, C.H. and Chiu, A.S. (2011). Evaluate municipal solid waste management problems using hierarchical framework. *Procedia-Social and Behavioral Sciences*, 25: 353-362.

Lombardi, E. and Bailey, K. (2015). The Community Zero Waste Roadmap; Eco-Cycle Soutions: Bolder, CO, USA.

Lu, W. and Yuan, H. (2011). A framework for understanding waste management studies in construction. *Waste Management*, 31(6): 1252-1260.

Mace, M. and Szaky, T. (2016). Terra cycle: Recycling won't solve the waste dilemma, but consumers can. Available at https://edie.net/.

Manahan, S.E. (1999). Industrial Ecology: Environmental Chemistry and Hazardous Waste; Lewis Publishers: Boca Raton, FL, USA.

Mavropoulos, A. (2010). Waste management 2030+. *Waste Management World*, 11(2): 1-10.

Mavropoulos, A. (2011). Globalization, Megacities and Waste Management. ISWA conference, Daegu, Republic of Korea.

Mavropoulos, A. and Newman, D. (2015). Wasted health: the tragic case of dumpsites. Vienna, International Solid Waste Association, June.

Mavropoulos, A., Chohen, P., Greedy, P., Plimakis, S., Marinheiro, L., Law, J. and Loureiro, A. (2017). A Roadmap for Closing Waste Dumpsites: The World's Most Polluted Places. International Solid Waste Association (ISWA): Vienna, Austria.

McDonough, W. and Braungart, M. (2010). Cradle to cradle: Remaking the way we make things. North point press, USA.

Mezher, T. (2011). Building future sustainable cities: The need for a new mindset. *Construction Innovation*, 11(2): 136-141.

Moore, C.J. (2008). Synthetic polymers in the marine environment: a rapidly increasing, long-term threat. *Environmental research*, 108(2): 131-139.

Palmer, P. (2004). Getting to zero waste. Purple Sky Press.

Pollans, L.B. (2017). Trapped in trash: 'Modes of governing' and barriers to transitioning to sustainable waste management. *Environment and Planning A*, 49(10): 2300-2323.

Porse, E. (2013). Storm water governance and future cities. *Water*, 5(1): 29-52.

Premalatha, M., Tauseef, S.M., Abbasi, T. and Abbasi, S.A. (2013). The promise and the performance of the world's first two zero carbon eco-cities. *Renewable and Sustainable Energy Reviews*, 25: 660-669.

Ramesh, V. and Kodali, R. (2012). A decision framework for maximising lean manufacturing performance. *International Journal of Production Research*, 50(8): 2234-2251.

Riffat, S., Powell, R. and Aydin, D. (2016). Future cities and environmental sustainability. *Future cities and Environment*, 2(1): 1-23.

Rogers, R. and Botsman, R. (2010). What's mine is yours: the rise of collaborative consumption. HarperBusiness: New York, NY, USA.

RUFS (2010). Office of Regional Planning, Stockholm County Council, Office of Regional Planning, Stockholm County Council.

Ryan, P.G., Moore, C.J., van Franeker, J.A. and Moloney, C.L. (2009). Monitoring the abundance of plastic debris in the marine environment. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1526): 1999-2012.

Schmidt, M. (2012). Retail shopping lists: Reassessment and new insights. *Journal of Retailing and Consumer Services*, 19(1): 36-44.

Seadon, J.K. (2010). Sustainable waste management systems. *Journal of Cleaner Production*, 18(16-17): 1639-1651.

Seltenrich, N. (2013). Incineration versus recycling: In Europe, a debate over trash. Environment 360: Opinion, Analysis, Re-

porting & Debate.

Sentime, K. (2014). The impact of legislative framework governing waste management and collection in South Africa. *African Geographical Review*, 33(1): 81-93.

Serpe, A., Rigoldi, A., Marras, C., Artizzu, F., Mercuri, M.L. and Deplano, P. (2015). Chameleon behaviour of iodine in recovering noble-metals from WEEE: towards sustainability and "zero" waste. *Green Chemistry*, 17(4): 2208-2216.

Seyfang, G. (2005). Shopping for sustainability: can sustainable consumption promote ecological citizenship?. *Environmental Politics*, 14(2): 290-306.

Silva, A., Rosano, M., Stocker, L. and Gorissen, L. (2017). From waste to sustainable materials management: Three case studies of the transition journey. *Waste Management*, 61: 547-557.

Snow, W. and Dickinson, J. (2003). Getting There!: The Road to Zero Waste: Strategies for Sustainable Communities. Zero Waste New Zealand Trust.

Song, Q., Li, J. and Zeng, X. (2015). Minimizing the increasing solid waste through zero waste strategy. *Journal of Cleaner Production*, 104: 199-210.

Stern, N. (2009). The global deal: Climate change and the creation of a new era of progress and prosperity. PublicAffairs.

Stockholm City (2009). Stockholm City Plan: Summary.

Tennant-Wood, R. (2003). Going for zero: a comparative critical analysis of zero waste events in southern New South Wales. *Australasian Journal of Environmental Management*, 10(1): 46-55.

Thompson, A. (2014). Burning trash bad for humans and global warming. Scientific American, September.

Troschinetz, A.M. and Mihelcic, J.R. (2009). Sustainable recycling of municipal solid waste in developing countries. *Waste Management*, 29(2): 915-923.

UNEP (2009). Developing Integrated Solid Waste Plan: ISWM Plan–Training Manuals Volume 1–4; United Nations Environmental Programme Division of Technology, Industry and Economics, International Environmental Technology Centre: Osaka/Shiga, Japan.

UNEP/GRID-Arendal (2006). A History of Waste Management.

UN-Habitat (2010). Solid Waste Management in the Worlds0s Cities; Earthscan: London, UK.

USEPA (2013). Solid Waste Management Hierarchy.

Van Ewijk, S. and Stegemann, J.A. (2016). Limitations of the waste hierarchy for achieving absolute reductions in material throughput. *Journal of Cleaner Production*, 132: 122-128.

Veleva, V., Bodkin, G. and Todorova, S. (2017). The need for better measurement and employee engagement to advance a circular economy: Lessons from Biogen's "zero waste" journey. *Journal of Cleaner Production*, 154: 517-529.

Verstraete, W. and Vlaeminck, S. E. (2011). ZeroWasteWater: short-cycling of wastewater resources for sustainable cities of the future. *International Journal of Sustainable Development & World Ecology*, 18(3): 253-264.

Waste Watch UK (2004). Zero Waste International Alliance. History of waste and recycling, in waste online information sheet; Waste Watch UK: London, UK.

WasteMINZ (2018). Eunomia Research & Consulting. Rebooting Recycling-What can Aotearoa do? A discussion paper presented by the waste management institute of New Zealand (WasteMINZ); Eunomia Research & Consulting: Auckland, New Zealand.

Wiedinmyer, C., Yokelson, R.J. and Gullett, B.K. (2014). Global emissions of trace gases, particulate matter, and hazardous air pollutants from open burning of domestic waste. *Environmental Science & Technology*, 48(16): 9523-9530.

Wilson, D.C., Rodic, L., Modak, P., Soos, R., Carpintero, A., Velis, K., Iyer, M. and Simonett, O. (2015). Global waste management outlook. UNEP.

Zaman, A.U. and Lehmann, S. (2013). The zero waste index: a performance measurement tool for waste management systems in a 'zero waste city'. *Journal of Cleaner Production*, 50: 123-132.

Zaman, A.U. (2014) Zero waste. *Journal of Cleaner Production*, 1-14.

Zaman, A.U. (2015). A comprehensive review of the development of zero waste management: lessons learned and guidelines. *Journal of Cleaner Production*, 91: 12-25.

Zaman, A.U. (2017). A strategic framework for working toward zero waste societies based on perceptions surveys. *Recycling*, 2(1): 1.

Zaman, A.U. and Lehmann, S. (2011). Challenges and opportunities in transforming a city into a "zero waste city". *Challenges*, 2(4): 73-93.

Zaman, A.U. and Swapan, M.S.H. (2016). Performance evaluation and benchmarking of global waste management sys-

tems. *Resources, Conservation and Recycling,* 114: 32-41.

Zeng, X., Sun, Q., Huo, B., Wan, H. and Jing, C. (2010). Integrated solid waste management under global warming. *Open Waste Management Journal,* 3: 13-17.

Zero Waste SA Strategy (2010). Consultation draft 24 (2010-2015).

Zero Waste South Australia (2013). South Australia's Kerbside Three-Bin System Waste Report.

ZWIA (2004). Zero Waste Definition Adopted by Zero Waste Planning Group.

ZWIA (2009). Global Principles for Zero Waste Communities; Zero Waste International Alliance (ZWIA): Brighton, UK.

****

Cite this chapter as: Ali, S.R. and Kumar, R. (2019). Strategic framework and phenomenon of zero waste for sustainable future. In: Kumar, V., Kumar, R., Singh, J. and Kumar, P. (eds) Contaminants in Agriculture and Environment: Health Risks and Remediation, Volume 1, Agro Environ Media, Haridwar, India, pp. 200-215, https://doi.org/10.26832/AESA-2019-CAE-0167-015