Zero Waste: A Sustainable Approach for Waste Management

Chapter · January 2020

DOI: 10.4018/978-1-7998-0031-6.ch008

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Chapter 8
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A Sustainable Approach for Waste Management

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ABSTRACT

Zero waste management means the holistic concept of waste management which recognizes waste as a resource produced during the interim phase of the process of resource consumption. Zero waste strategies may be applied to companies, to communities, industrial sectors, to schools, and homes since they include many stakeholders, not only those of the environment, but also technological aspects. Sustainability is also strongly supported by environmental protection, cost reduction, and additional jobs when it comes to waste management and handling back into the industrial cycle. Lowering global resource requirements force us to consider resource management and product management. The management of zero waste is therefore a holistic view of the sustainable avoidance and management of waste and resources. Although there are many null practice approaches and null waste approaches in the modern world, zero waste is a very complex system, and in the future, there are still many works.

INTRODUCTION

In 1973, Dr. Paul Palmer first applied the term "zero waste" to recover chemicals (Palmer, 2004). Zero waste approach is one of the most widely studied concept but still the most controversial topic in recent decades in waste management research (LaBrecque et al., 2015; Greyson et al., 2007). Zero Waste (ZW) is defined as "a system to design and management of products and processes for waste removal and

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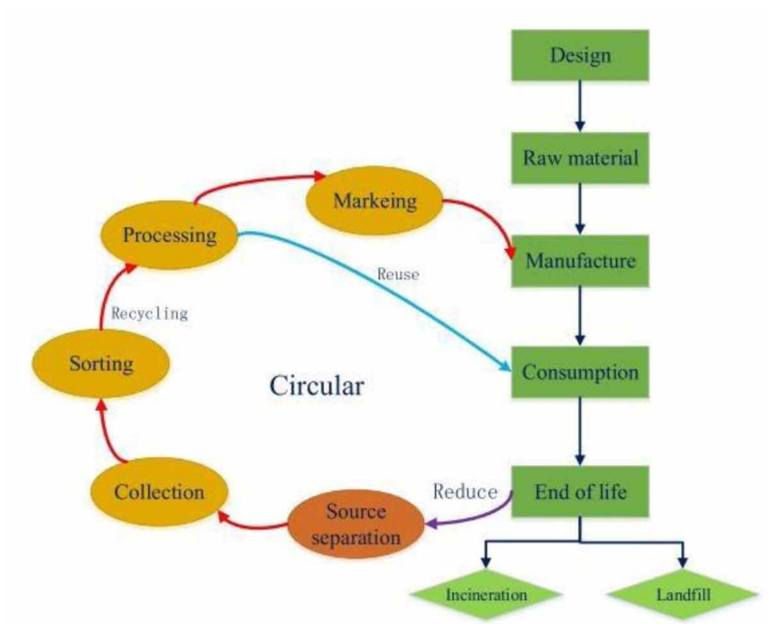
material retention and rehabilitation, not burning or burying" (Zero Waste International Alliance, ZWIA, 2004). ZW is therefore concerned with waste prevention through sustainable design and consumption practices, optimal waste recovery and not waste management by landfill or incineration (Zaman, 2015). ZW supports waste prevention and avoidance rather than waste treatment and disposal strongly. It is understandable; It may however not be feasible, under the existing resource consumption and waste management systems, to achieve nil incineration and nil landfill targets. Waste was dealt with as a burden and social problem and was therefore largely managed by "end-of-pipe" solutions such as waste disposal systems (Zaman et al., 2015). The traditional waste management system, which mainly relies on sites, significantly pollutes our environment, thus requiring an improved and efficient waste management system with a limited exception in developed countries. Thus the zero-waste objective, using industrial symbiosis, recycling or "up cycling," is to use and consume resources within a circular economic model with minimum environmental degradation, based on the "no-waste" principle from nature. Local governments and business organizations frequently use strategic waste management plans to manage waste issues (Liao et al., 2011). For a successful implementation of a waste management plan it is essential to establish an effective planning process (King et al., 2016). Several studies on the development of waste management frameworks have been conducted, including decision frameworks, legislative frameworks and hierarchical frameworks (Sentime et al., 2013). A framework assists decision-makers in understanding, improving, assessing and guiding waste management systems. The 3R principles (reduction, recycling and reuse) are among the top three in the waste hierarchy and are regarded as the founding principles of the sustainable waste management system (Murphy & Pincetl, 2013; Mason et al., 2003; Colon & Fawcett, 2006). The "3R" principles were extending to five steps in the waste hierarchy in the European Union Waste Framework Directive 2008, including prevention (avoidance), recycling (including recovery of energy) and disposal. Waste prevention is a major problem of zero waste and calls for collective social sensibility and knowledge of waste, innovation in production and business models (Cox et al., 2010). Awareness and transformative knowledge in relation to the choice of pro-environmental lifestyle are often believed to motivate behavior change (Jackson et al., 2005). Waste management and processing technologies have been used over centuries to solve waste problems (Greyson, 2007; Matete & Trois, 2008). Zero waste believes that technology alone cannot solve waste problems on the basis of community participation, service infrastructure, regulatory policy and ecological treatment technology in a sustainable manner. Nevertheless, it limits the application of waste energy (WTE), which consumes waste to make electricity (heating and electricity) and waste disposal in an "ideal" zero waste environment, between traditional waste handling and non-residual waste management. Figure 1 shows the symbolic material flux of a circular waste system, when the end-of-life product or output waste is treated and used as metabolism process (Curran & Williams, 2012; Matete & Trois, 2008).

Zero Waste Strategy and Solid Waste Management

Continuing population growth, booming economy, rapid urbanization and rising standards of community living have greatly accelerated the generation of solid waste worldwide, particularly from developing countries (Guerrero et al., 2013). Solid waste is now a global ecological issue (Seng et al., 2010) as global volume of solid waste is estimated to be around 11 billion tons per year (2.5 tons of trucks can rotate around 300 circles around the equator) in 2011, with solid waste production per capita at about 1.74 tons / year worldwide. The large volume of waste has also created enormous pressure on the waste management authority to be more sustainable way to achieve sustainability (Cheng & Hu, 2010). Cur-

Figure 1. Cyclic and linear resource flow



rent society is driven towards greater sustainability by global climate changes and their diverse effects on human life. Lowering global finite resources also forces us to take resource and product management into account. One approach to zero waste was therefore proposed to address these concerns (Phillips et al., 2011). A state of zero wastes may finally become a necessity in the world with limited resources because of the great environmental pressures. Currently some good zero waste practices in cities, businesses, individuals and waste recycling industries have been proposed and implemented (GAIA, 2013). Following case-studies should inspire the urban, the private and the waste recycling industries to pursue their own zero waste efforts and the development of the new zero waste investment and implementation plans for the organizations and individuals concerned.

ZERO WASTE CITIES

Adelaide, Australia

Adelaide is South Australia's capital city and includes 19 municipalities in an urban area of 8415 km^2 with population 1,089,728 (UNHABITAT, 2010). The City Council of Adelaide (ACC) is responsible in Adelaide for waste management. Zero Waste SA (ZWSA) is a government organization created under the Zero Waste SA Act of the South Australian state. ZWSA allows people to improve recycling and waste management practices in their homes, workplaces and industry (ZWSA, 2011). Adelaide has a high percentage of waste collection systems in relation to other capital cities in Australia in waste management systems. The legislation on the deposit of containers has been adopted in 1977; therefore, it is more than thirty years since recycling of various containers. Zero Waste SA works in Southern Australia to achieve a zero-waste area (Zaman, 2013).

Community Action, Taiwan, China

Taiwan was confronted by a waste crisis in the 1980s because there was no room to increase its site deposits. When the government turned to mass incineration it not only stopped dozens of burners being made by the vicious opposition of the community, it also pushed the Government to adopt waste prevention and recycling targets and programs (Allen, 2012b). These policies and programs were so effective that waste volumes decreased significantly, even as both population and gross domestic product grew. Its waste disposal rate was around 48.82 percent, and waste per capita expenditures were 25.40 dollars a year. The government, however, has cut down on the potential of waste prevention strategies through the maintenance of both pro-incinerator policies and waste prevention policies, because large investments in incinerator drain resources could otherwise be used for their improvement and expansion.

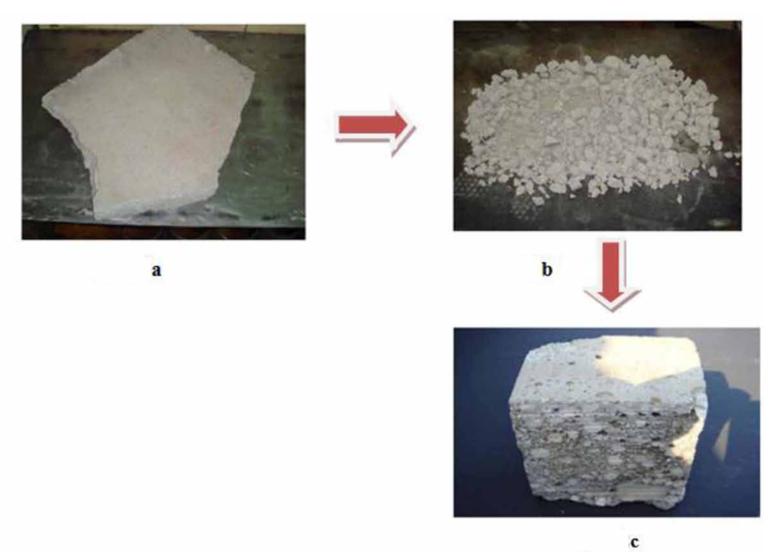
INNOVATIVE APPROACH FOR ZERO CONSTRUCTION WASTE

The building, one of mankind's most ancient activities, places an important influence on socio-economic development and also has an indelible influence on the environment and the surroundings. It affects the economic dynamics of society and has a significant environmental and environmental impact. Construction activities have long-term consequences both for the change of the appearance of the region, as well as for the management and management of natural resources. Innovation is of vital importance not only to those in a given region (region, state and like) that want to increase or sustain economic growth, but also to those who benefit directly. Production is therefore no longer a core problem that should influence or modify the economic course of development or improve quality of life as much as possible. Since the majority of natural resources are non-limited and renewable, we can guarantee equality of opportunity only if we are responsible for the management of resources. The EU has set one of its main targets, in its sustainable development strategy, the breaking down of links between economic growth, natural resource utilization and waste production (Hart, 2007). The recycling model for lightweight aggregate construction waste is developed to include environmental considerations.

Model Approach for Zero Construction Waste

In order to include environmental performance in designing building operations and minimizing construction waste, the model for recycling construction waste from lightweight aggregates containing expanded-glass was created. The quantity of waste lightweight concrete (LWC) made of expanded glass is currently less important, and this raises the question of whether such waste can be collected separately and economically. But the recycling or re-use of a building is usually better from an environmental point of view than the demolition, because of the environmental cost of energy, water and renovation and reuse materials are fewer. Life cycle assessment (LCA) has been used frequently during recent years to assess environmental issues linked to the management of solid waste (Grant et al., 2003). The main benefit of using LCA for solid waste management systems is that the approach systematically covers all the impacts of waste management, including all processes of solid waste systems and of waste management systems upstream / downstream (Kirkeby et al., 2006). In the last decade, several models for environmental evaluation of municipal solid waste treatment and disposal have been presented. The IWM (McDougall et al., 2001) model reflects life cycle thoughts on city waste management, first with a chart and then with a more advanced model for calculating the inventories of life cycles. We started with LCA in our research. LCA is a standardized tool designed to minimize potential environmental, human health and resource impacts. Therefore, limits are defined more narrowly as the economy is not covered (Hansen & Gilberg, 2003; Kirkebyet al., 2006). Creative cooperation and the new philosophy of waste management have led to a new perspective: resting (or residing) and waste (building) material is the material raw (building). The production of cement from lightweight aggregates is made from a number of raw materials. One of these is LWC with expanded glass aggregates. The raw material for LWC with expanded glass or recycled glass added aggregate which employs - to all intents and purposes a perfect recycling system every year in the Federal Republic of Germany for millions of tonnes. LWC's expanded glass aggregates make use of only the precious raw material, which the glass industry is unable to use for technical reasons for the production of new, e.g., fine glass shards. This makes a significant contribution to the development of the recycling process of glass with aggregates containing expanded glass while at the same time protecting natural resources. In addition to its areas of application for the classical and other construction materials industries, LWC with expanded glass aggregates is also becoming increasingly popular for special applications. The LWC waste from aggregates containing expanded glass can be seen in Figures 2a to 2c.

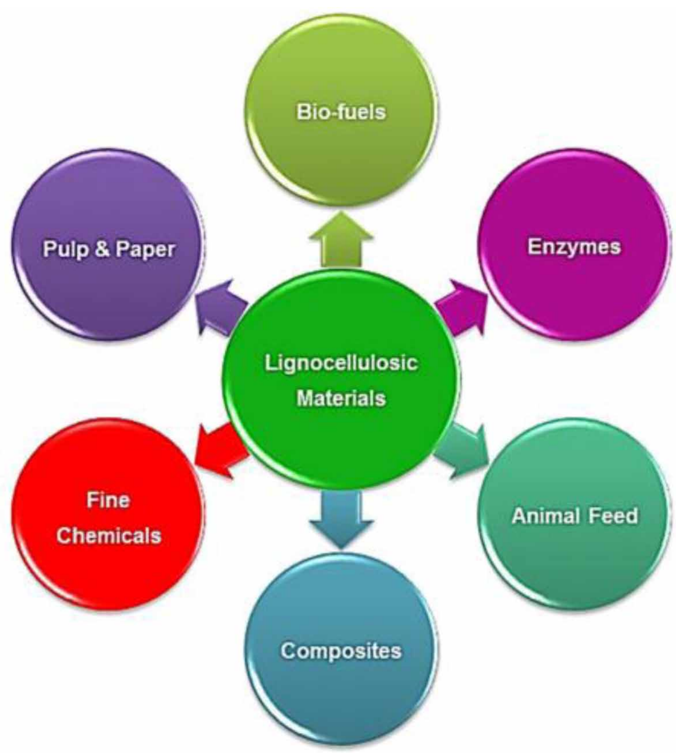
Figure 2. (a) LWC waste of LWC from aggregates containing expanded glass. (b) Crushed LWC waste from LWC with aggregates containing expanded glass. (c) Recycled "new material from LWC with aggregates containing expanded glass
(Kralj, 2011).



Zero Waste Approach Via Bio-Refinery Using Sustainable Material: Lignocellulose

Diverse aspects of biorefinery as a sustainable technology for the processing of' materials' of lignocelluloses into value-added products have been examined. There have been considerable explicit efforts to convert the lignocellulosic into value-added products, including composites, fine chemical, animal feeding stuffs, pulp and paper, biofuels and enzymes (Figure 3). In many processes relating to lignocellular biotechnology, it has shown significant improvements over the past few years and has triggered broad and innovative studies of lignocellulose, various fungal consortia and ligninolytic enzymes, including lignin peroxidase (LiP), manganese peroxidase (MnP), and laccase (Lac), their purification and immobilization to present their potential for a wider spectrum of biotechnological applications (Iqbal et al., 2013; Asgher et al., 2017). Innovations in the world of bio-refiners are offering a portfolio of sustainable and eco-efficient products to compete in the petroleum-based products market which is currently dominated by intensive research. It is interesting that a bio-refinery has enormous potential for using / capitalizing all kinds of biomass sources, including agricultural, agro-industrial, algae and municipal resources. Historically speaking, bio-based producers have targeted value-added products, chemical platforms and specialty markets, where multi-functionality often plays a critical role to justify the objective of the end product. This integrated transition from the petrochemical approaches mentioned above to a sustainable bio-refinery has numerous justifications (Langeveld et al., 2012; McCormick et al., 2013).

Figure 3. Lignocellulose bio-conversions into value-added bio-products
(Iqbal et al., 2013)



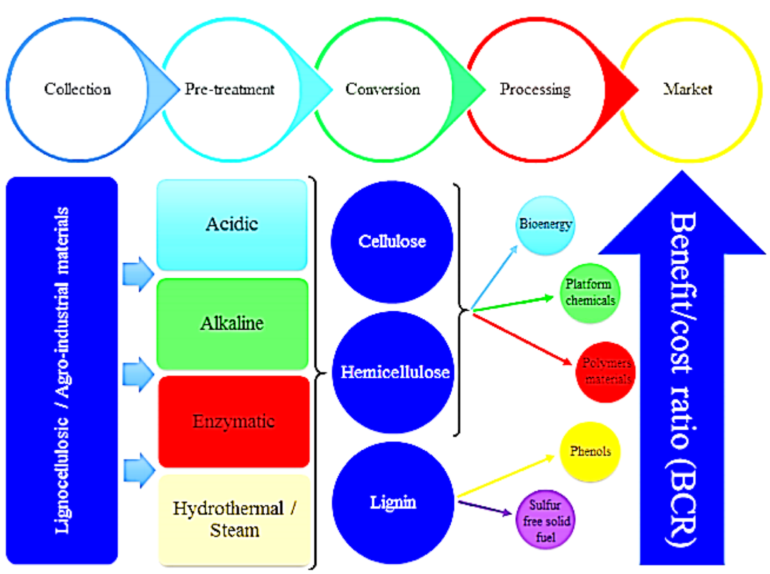
- To prevent excess dependence on petrochemical products
- To avoid price increases
- To avoid over - consumption of petroleum, gas, coal and other potential minerals
- To enhance and diversify bio - renewable sources
- In addressing global climate issues
- Greenhouse gas emissions
- To safeguard the natural ecosystem and
- To boost regional and rural greener growth

The schematic representation of the above-mentioned concept of biorefinery platforms is shown in Figure 4. Bio-refinery is normally based on sugar fermentation, e.g. C5/C6, extracted from many feed-stocks based on natural polysaccharides. Different types of bio-refineries were proposed or developed by researchers based on the raw materials and processing techniques (Parajuli et al., 2015). The dimethyl ether was used for intermediate assessment of a thermochemical bio-refinery consisting of 12 procedures for the manufacture of ethanol, methyl acetate, hydrogen and electricity, as up to 50.20% was achieved with energy efficiency. For this process, an economic analysis was carried out, which concluded that there is a greater profitability for a thermochemical bio-refinery than for normal thermochemical processes, which adds more than one product to produce (Haro et al., 2013).

Green Bio-Refinery (GBR)

A green bio-refinery system is also considered to be a complex, yet multi-functional and fully integrated system which have great potential to use green biomass, such as grazing, to produce various products, like fibers, fuel, animal feed, or as a component of the bio-refinery of lignocellulose. Furthermore, new

Figure 4. Schematic representation of bio-refinery platform concept
(Iqbal et al., 2013)



resource protection machinery for the full use of residual biomass was also considered. The production of ethanol is one of the main aims of a green bio-refinery. The following ethanol bio-refineries have been investigated from various sources: from starch via grinding (wet or dry) and fermentation, which is integrated into animal feed production (Scholey et al., 2016). For the production of ethanol and also as a typical bio-refinery for the production of animal feed the use of *Faba beans* was also proposed, as a green bio-refinery (Karlsson et al., 2015). A different kind of beans were used in an integrated bio-refinery with field bean seeds for the production of ethanol, feed components and the bonus of an edible and ethanol-producing fungal biomass (N. *intermedia*) (Pietrzak et al., 2016). In terms of industry and biotechnology, a broader spectrum of natural, agro-industrial and lignocellulosic polysaccharide substrates is available for the (bio) process into high value and industrial products. In the last decade, a major development has been achieved in many integrated bio-refinery approach procedures for the future. Due to increasing socioeconomic concern, targeted markets have been identified in recent years for possible applications such as alternative types of energy, industrially relevant enzymes, platform chemicals etc. The (bio) conversion of such natural substances to auxiliary resources to satisfy the demands of both industry and modern society has been the most striking (Sakamoto et al., 2012; Shahsavarani et al., 2013).

Zero-Waste Design for Sustainable Fashion

Zero-waste design is popular as a sustainable manufacturing way. In many other manufacturing regions Subaru, Proctor & Gamble, DuPont and Caterpillar are just some of the businesses that boast of their zero-waste-to-landfill facilities. The result of this design can be sustainability, but null-waste design can also be a tremendously creative challenge. The designer does not only create a creative reflection on model shapes of the cloth, but also needs innovative sewing, seam closings and seam construction. The concept of zero-waste clothing therefore seeks to eliminate any wasteful clothing from the production process by developing designs using 100% of the length of the cloth, so that no waste hits ‘the ground for the cutting room.’ The most common method of manufacturing apparel in cutting clothing production is that of cutting material waste by average 15 percent (Rissanen, 2011; Townsend & Mills, 2013). The reason is that design parts for most clothing items have irregular shapes which do not combine perfectly like pieces in a puzzle. The fashion industry uses different methods for minimizing this waste, such as software for planning the introduction of model cutting parts (which is similar in part to resolving the puzzle on the computer) or cutting multiple sizes and styles together. However, these methods do not eliminate the waste material that ends in the cutting room floor in its entirety. The focus of the paper is on the challenge of designing garments that do not produce waste when cutting while the scraps are recycled (denim insulation) or recycled (appliqués, pillow stuffing). Indigenous garments have used zero waste for centuries The Indian sari, a cloth long, is often remembered as draped and wrapped around the body without being cut or stitched. The Japanese kimono is also a null-waste, but is made of cut and sewn fabric pieces. Therefore the challenge for designers of a sustainable nature is to create styles that could be adopted in west mode within zero-fabric waste parameters. Cutting waste generated is important as ‘the clothing industry accounts for 7% of global carbon emissions, Ericson (2010) estimates. The trend of eco-mode (Thomas, 2008) has led to sustainability talks that have often focused more on organic textiles and fair labour practices instead of minimising waste. Designers like Yeohlee Teng and Tara St. James include zero-waste practices, but they not only design zero-waste solutions. The emerging designer Titania Inglis used zero waste design practices to design collections and received the 2012 Sustainable Design award of the Ecco Domani Fashion Foundation (Swanson, 2012). Certainly, a great deal contributes to sustainable fashion design practices; the Textiles Environment Design Project (2012) outlines 10 strategies for sustainable design, with' design to minimize waste' as first in its list. In comparison with other sustainable practices like recycling materials and using organic dyes, while minimizing waste involves not just the cutting of zero wastes, literature is very lacking in designing textile clothes for zero waste cutting. Indeed, in the recent article of Townsend and Mills (2013), the limited information on the use of (zero-waste pattern cutting) was mainly provided by contemporary designers, including Holly McQuillan and Julia Lumsden. The authors began a study of the design and literature of zero-waste clothing by examining current and historical examples. Thankfully, the designer will study the practice for you the authors started a study of the design of non-discharge clothing by examining contemporary and historical examples and the literature available. Fortunately, designers frequently share the design pattern of their non-waste clothing for a study of the practice, including the YIELD catalog (McQuillan & Rissanen, 2011).

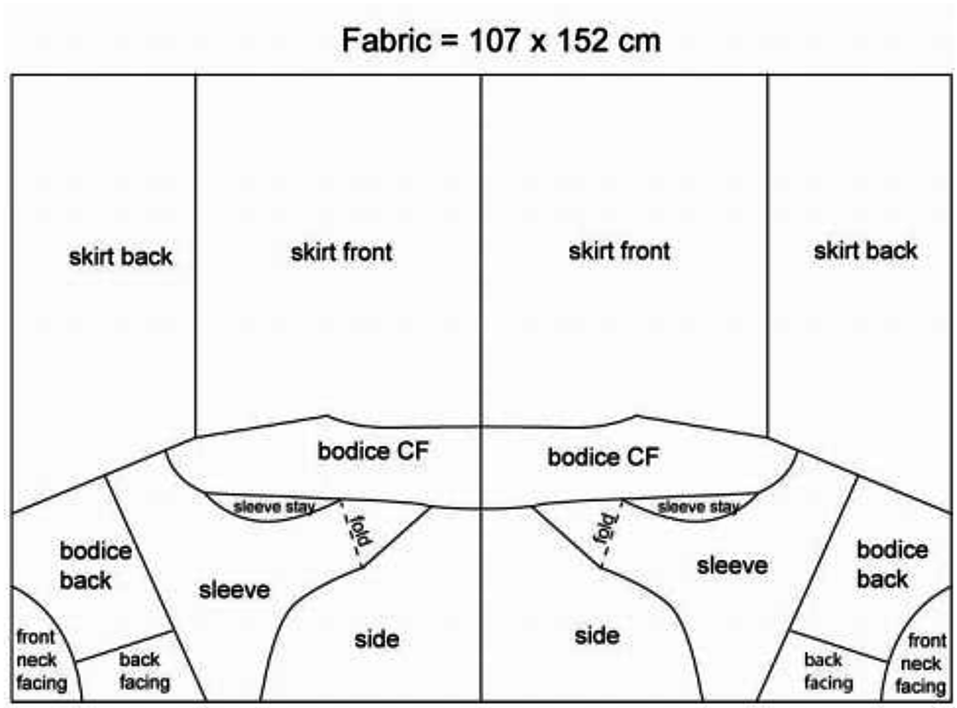
Jigsaw and Embedded Jigsaw Design Practices

In terms of the embedded puzzle practice, the design process is the same for embedded designs as for traditional puzzles. The built-in puzzle has become more effective when multiple clothe materials are manufactured and less of a new way of designing null-waste patterns. By integrating a traditional pattern into a fabric length, McQuillan suggests that what is waste from the traditional pattern can be used to produce zero waste in a different garments design. The study focused on puzzle practice and ignored the embedded since the authors practise individual clothing. In contrast, both puzzles and embedded puzzle methods allow designers to use different pattern forms, much like traditional design patterns. However, the design forms in the puzzle are manipulated to lock each other and share the cut edges to achieve zero waste. Timo Rissanen and McQuillan are both well-known for their workmanship. The practice of puzzles provides a way of working which is comfortable for seasonal designers since it allows the designer to build a set design, whether it is the sleeves, pant legs or any other established pattern piece. The little black PARTY dress (Figure 5) in which the raglan sleeved is the shape of a cursive r (r) lower case with the original idea that the pattern forms would form the letters P-A-R-T-Y. The rest of the models were developed in the form of drafts and designs at the same moment, and a possible decision was reached to abandon the hope that the word ‘ party’ remained intact within the design.

Multiple Cloth Approach

McQuillan describes this practice as “a way to design two or more designs for various fabrics simultaneously.” This could indeed be the most similar to mass production methods for marking patterns by combining several styles into one layout. While the integrated puzzle practice can also produce multiple garments in one marker, McQuillan’s approach to the multi clothes shows results with only illustrated examples of two hooded jackets and two t-shirts. When designing for mass consumption, multiple clothing linked to fabric is essential, since the repeat of textiles contributes towards esthetic cohesion. However, once again, because the studios of the authors are not willing to produce multiple clothes, they have not taken up the task of designing in several clothes. The combination of cutting several garment patterns from the same cloth is shrewd and functional, and zero waste can be achieved. However, this study focuses on exploring methods of zero waste on individual clothing. During zero residue design surveys, McQuillan’s view of zero-waste design practice was adopted by the authors as one of' the cre-

Figure 5. Design and layout of little black PARTY dress
(Melanie et al., 2013)



ative advantage of unpredictable design processes as a creative advantage. Hopefully, zero waste clothing design will thrive as more designers study practices, be they based on sustainable interests or just on a new creative pattern challenge. There are some obstacles to overcoming practices that are feasible in mass production. More experiments are necessary to find ways of making the zero-waste patterns the world's second largest polluting sector, as fashion industry.

Economic Growth, Sustainability, or Zero Waste

Numerous provinces and nations, including: DuPont, Fuji Xerosox, Collins Pine, Ricoh, Konika-Minolta, NEC, Toyota, Hewlett Packard, Epson and Interface have made "zero waste" commitments, with the following companies increasingly being: South Australia, Victoria, Western Australia, New Zealand, Lebanon, Taiwan and China. This shows widespread progress in preventive thought, technical performance and exemplary initiatives. The zero waste objectives, however, is often pursued gradually: no waste is reduced in reality. More than just a preventive objective, a prevention approach is needed. Common terms for describing social objectives are not ideal. The traditional aim of economic growth is to undermine sustainability, while sustainable economic growth, which is traditionally sought in ways that undermine economic growth (by over-regulation, but not by impact), is undermined. The public make little use of' sustainability' and' sustainable development' and are regularly abused by organizational and governmental bodies seeking approval for gradual improvements. Zero waste' is often misinterpreted as unrealistic, because it cannot be achieved with the economic signals of today but with different signals on a global scale. The potential for preventive approach is apparent to zero waste and sustainable development. Economic growth could also be compatible with a preventive approach is less well recognized. The counterproductive competition between economic, social and environmental objectives demonstrates the need for a review and adaptation of societal objectives (rather than balance and compromise). Renewed society objectives invite the most powerful intervention in the complex system to renewed thinking and international views (Meadows et al., 1999; Rob 1999).

A Goal-Set and Actions to Achieve the Goal-Set

The incremental approach frequently makes plans with weak connections to long-term objectives. Current trends are identified and measures to improve the situation are chosen. This method of planning is called' foresight.' Backcasting' (Robinson et al., 1990) is a preventive approach whereby planning is based on objectives instead of the present. Backcasting can be likened to traveling to a preferred destination rather than to the unwanted environment. Backcast does not hinder actions to meet longer-term goals by reducing current impacts. Backcasting helps to ensure that measures to minimize current impacts are not hindering measures to achieve long-term targets. The economist Kenneth Boulding described the 1966 goal proposed: a' cercular economy' is an economic growth, sustainability and no waste compatible long-term goal. The actions taken to implement a circular economy are appropriately described in a word first used in 1988 by Maureen O'Rorke, the social marketing manager. The combination of objectives and actions is the basis for society, economic renovation, the planning of projects and the daily making of decisions.

Action to Prevent a Range of Problems

The scope of precycling knowledge has expanded over time to include product-driven measures by households, municipalities, retailers, businesses and industry (Baldwin et al. 1997). Precycling can now be understood to include all the actions which create new resources for old products, in industrial, social, environmental and economic circumstances. Reduction, reuse, recycling, recomposting, composting and pyrolysis infrastructure can be extended to enhance product capacity. Industrial independence from known accumulated substances can be enhanced for this purpose (persistent synthetics, heavy metals, fossil fuels, radiation) as they too can be elevated so that substitution can become precycled. Environmental habitats can be wider and diversified so that more emissions and effluents can become natural resources. The ability of society to satisfy every need can be increased so that everybody can precycle. The economy can become more circular, enabling economic, environmental and social objectives to be achieved in parallel. New resources for people and for nature could be created on a' recycled planet' at a rate similar to that of today's problem waste. Forms of precycling are many actions that minimize impacts. For example, recycling is one way to precycle as action is taken prior to the release of materials into the environment. But precycling is ambitious rather than recycling. Each product is recyclable today and any error can only be corrected by pre-cycling it (Boulding et al., 1996).

From Recycling Insurance to Precycling Insurance

The practice of recycling insurance can be converted into an economic instrument for market correction for the implementation of a circular economy:

- The full spectrum of products can also be covered.
- The full range of producers may require participation, which maintains equity and encourages economic improvements.
- The whole range of waste prevention and problem prevention opportunities can be financed. Recycling funding is only one opportunity for precycling. Other opportunities include restoration, redesign, substitution, phasing out, and more effective or alternative ways to meet needs, local repair / reuse, expansion of environmentally friendly habitats and biodegradation of substances.

A generalized form of reclassification, known as "precycling insurance" (Wright, 1982), could support all forms of precycling. Government would be required, just like any economic instrument, to legislate and monitor a precycling insurance scheme. If government also collects and invests premiums, however, additional taxation will inevitably be perceived. Clearly precycling insurance is not a tax, as it is reasonably expected that producers are responsible for their own products and not to charge society with avoidable costs. The costs of premiums are shared by the market and not by government throughout society. Insurance undertakings or non-profit organizations could operate a scheme. Insurance companies have an expertise in risk calculation, investment management, and problem prevention. Even if precycling insurance reduces claims for other businesses, the diversification of the insurance companies into management consequences remains clear before it happens (Holmberg, 2000).

Precycling Insurance

Precycling insurance will then establish premiums according to the risk that a product will become a waste instead of a new resource for people or nature. Prime funding would fund pre-cycling measures. Substantial products, such as soap, gold, silver jewellery and aluminum beer kegs, with insignificant risks would be awarded low fees (Gillilan, 1996). The waste risk would be small if: products can be easily recycled or biodegraded; the manufacturer has invested in end time treatment; and the product does not accumulate in the land, atmosphere or in the sea. This last factor is concerned with the acute effects of known substances such as heavy metals, mineral fuels and persistent synthetic compounds (CFCs, PCBs, DDT, etc). Pre-cycling insurance and normal market forces could compatible with a circular economy by using fuels, heavy metals, pesticides, automobiles, houses and sofas (and anything else). Larger economic, social and environmental damage can be avoided through the inclusion of lower prevention costs in the purchase price while offering manufacturers new market opportunities and maximum freedom of choice. In 2003, the recycling assurance was first sold as a service to manufacturers with products required for end-of-life recycling by Swedish insurer Lansforsakringar Miljo (Miljo, 2002). This insurance, guaranteeing payment of all future recycling charges can be purchased by producers instead of arranging recycling themselves.

Zero Waste to Industrial Networks

Project ZeroWIN

ZeroWIN, a five-year project, running between 2009-2014 which was funded by the EC under the Seventh Framework Programme, established by the Towards Zero Waste in Industrial Networks (www.zerowin.eu). It consists of 30 academic and industry partners throughout Europe (and one in Taiwan) that integrated their skills to allow the strategies chosen to be studied in real-life case studies. The Consortium investigates and demonstrates, by adopting a network approach and combining methods & tools, using technology and design and innovations and policy measures, how the closed-loop philosophy can help to achieve zero waste. The ZeroWIN partners have elaborated the draft proposal from the common perspective that the zero waste objective has been necessary and achievable, that there has been a clear and determined need for research in this field, and that such an ambitious study has required a consortium of research institutions and industries with the necessary research expertise and practical ability to achieve the project objectives. To develop the zero waste vision before decide which new technologies and methods for waste prevention to apply, and what tools to use, before developing the manufacturing model for optimisation of resources and prevention of waste. Quantitative evaluation of the success and the policy implications of the ZeroWIN approach was reported throughout the project and extensive dissemination of results was planned. Overall management and coordination have been formally integrated into a work package to ensure efficiency of the project. In four industries, ZeroWIN focused on two key waste types:

- Building and demolition waste
- Electronic / high-tech waste; from three areas:
- Electrical and Electronic Facilities (EEF)
- Car industry
- Photovoltaic sector (PV)

The ZeroWIN project has identified the best way to improve and bring together existing approaches and tools in an industrial system, as well as how to use innovative technologies to achieve a zero waste vision. The specific environmental targets were:

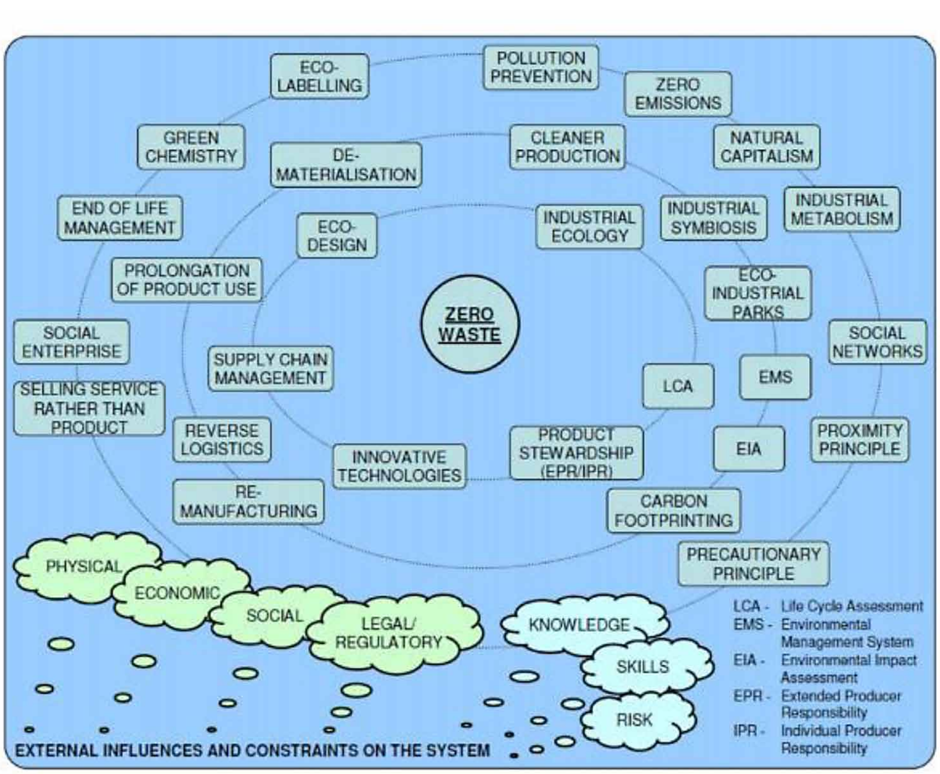
- 30% reduction in greenhouse gas emissions
- 70% overall reuse and waste recycling
- 75% decrease in freshwater utilization

Key Strategies Identified for Applying Zero Waste in Industry

A network approach and everyone involved will require a shared vision in order to achieve this, make best use of a number of existing waste prevention approaches as well as tools and technologies and develop new ones to improve the whole system.

1. **Eco-Design**: The design of system waste is especially important for real improvements in system-wide waste reduction (Figure 6). For ZeroWIN this principle includes extended use, de-materialisation and green chemistry concepts (Anastas et al, 1998; BSI, 2008).
2. **Industrial Symbiosis:** It's part of the concept of industrial ecology. This is particularly important for ZeroWIN, which is aimed at reaching zero waste by promoting industrial networks. The theoretical rationale and methods of information and resources sharing in different industries constitute industrial symbiosis; eco-industry parks are real world industrial symbiosis applications (Chertow, 2000, EPA, 2009; Baas et al., 2008, for example).
3. **Closed Log Supply Chains:** ZeroWIN developed a version of an established management strategy with a view to incorporating loop-closure reverse logistics and optimizing the supply, distribution and recycling flows of materials, produce and waste. The efficiency and sustainable performance of the industrial network were improved (Rogers et al., 2001; Dekker et al., 2003; Lambert, 2004).
4. **Uses of New Technologies**: Innovative technology can have powerful environmental and economic implications for new products and industrial processes. With ZeroWIN RFID and the D4R-Re-use, Recycle, Repair-Laptop and grid-connected and stand-alone PV systems, the investigation, design and testing of these systems was carried out.
5. **Management of Products:** Extended manufacturer's liability methods, and in particular individual manufacturer's liability (IPR), are viewed as important tools to enforce producers ' full responsibil-

Figure 6. Showing zero waste system proposed for ZeroWIN
(Curran et al., 2013)



ity, especially at the end of their lifetimes for their products (OECD, 2001 ; Tojo, 2004; Rossem, 2008).

6. **Life Cycle Assessment**: It is now recognized that measuring impacts from raw materials through the production and utilization phases to end-of-life throughout the physical life cycle of real product environmental impacts can lead to more sustainable production and consumption patterns) The measurement of the carbon footprint was also identified as important for further increased use of carbon objectives and budgets in Europe. LCA and carbon footprinting methods are used to evaluate the success of ZeroWIN's various waste prevention and case-studies in relation to greenhouse gas emission targets, waste and water use (Rex 2008; Borghi 2009 and JRC-IES 2009).
7. An Environmental Management System (EMS) plans, schedules, implements and oversees those environmental performance improvement activities. It provides organizations with a method to consistently manage their environmental activities, products and services and helps them meet their environmental obligations and achieve their performance goals. Many standards are available to model EMS. There are also standards available. ISO14001 and the eco-management and audit (EMAS) system at EU level are the most widely distributed on the international stage.
8. EMS is moderate to ZeroWIN because it can be regarded as an adequate support to manage sustainable industrial activities, but does not constitute a key issue for its development itself.

Zero Waste Index

The Zero Waste Index is a tool for measuring the potential of virgin materials for zero waste systems to be offset. One of the key objectives of the concept of null waste is the zero depletion of natural resources. The measurement of efficiency of the city of zero waste would therefore eventually measure resources that have been recovered, consumed, wasted, recycled and ultimately replaced with virgin materials and offset waste disposal systems. However, the rates of waste diversion do not indicate the waste management system's virgin material replacement efficiency which is very important in the conservation of global natural resources. This is why the zero waste index is a cutting-edge tool for measuring waste management systems in virgin material replacement. With the introduction of the zero waste global index, the potential compensation of virgin materials and the potential depletion of natural resources could be measured. The ZWI also provides a useful tool to compare various waste management systems across the city and provides a broader picture of the potential demand in the city for virgin materials, energy, CO_2 and water. Therefore, the ZWI is a performance indicator for evaluating the overall performance of waste management systems.

$$Zero\, waste\, index = \sum \begin{matrix} potential\, amount\, of\, waste\, managed\, by\, the\, city \\ *substitution\, for\, the\, systems \,/\, Total\, generated\, by\, the\, city \end{matrix}$$

$$Diversion\, rate = \frac{Weight\, of\, recyclables}{Weight\, of\, garbage + Weight\, of\, recyclables} \times 100$$

Recyclables = waste that is reused, recycled, composted or digested
Garbage = waste that is landfilled or incinerated (City of Toronto, 2012).

Many towns such as Adelaide, San Francisco and Stockholm currently try to be zero-waste towns by getting waste to 100% off site. However, for zero waste initiatives, diversion from waste and recycling are not sufficient. The diversion rate as indicated above does not include waste avoidance by industrial design, effective policies and behavior changes; therefore, waste diversion rate is not enough to measure the city's nil waste performance (Zaman et al., 2013).

CONCLUSION

The rapid economic growth and globalization produced a massive amount of waste and attracted the global attention due to potential environmental impact and resource waste, such as illegal dumping and the cross-border movement of industrial waste, informal e-waste recycling, food loss and the release of greenhouse gas, resource consumption. The idea of' zero waste' is therefore an efficient means to solve the problems of solid waste. Zero waste is to promote the redevelopment of resource life cycles in order to reuse all products. There have now been significant efforts in the cities, companies and individuals that offer many good suggestions for the future production of zero waste. In order to measure the performance of waste management systems, decision makers and waste experts use various indicators. In the past decade, waste diversion, green town and zero waste indexes were used to measure the performance of a town as a key indicator. In order to produce zero waste, certain key strategies, such as Eco-Design and Eco-Labeling should be applied from the extraction of raw materials to the end disposal. The zero waste management for solid waste, industrial waste, building waste and electronic waste must move beyond recycling, to the largely unknown territory of the higher end of the waste management, such as eco - design, eco - labeling, closed loop chain and clean production. The world's efforts at reducing its problems can ironically block a preventive approach. As currently practiced, zero waste, sustainability and sustained economic growth may not be achieved. The alternative suggested seems viable and feasible; it does, however, call for a change of thinking. People have always been inventive and have changed the face of the world, but how easy minds can change remains to be seen. Most people in the world already suffer from an increasing number of worse effects. All of these impacts are not guaranteed to remain tolerable until everyone is ready.

REFERENCES

Allen, C. (2012). *Taiwan: Community Action Leads Government Towards Zero Waste*. Available at http://no-burn.org/downloads/ZW%20Taiwan.pdf

Anastas, P., & Warner, J. (1998). *Green Chemistry: Theory and Practice*. New York: Oxford University Press.

Asgher, M., Ahmad, Z., & Iqbal, H. M. N. (2017). Bacterial cellulose-assisted de-lignified wheat straw-PVA based bio-composites with novel characteristics. *Carbohydrate Polymers*, *161*, 244–252. doi:10.1016/j.carbpol.2017.01.032 PMID:28189235

Baas, L. W., & Huisingh, D. (2008). The synergistic role of embeddedness and capabilities in industrial symbiosis: Illustration based upon 12 years of experiences in the Rotterdam Harbour and Industry Complex, Progress in Industrial Ecology. *International Journal (Toronto, Ont.)*, *5*(5–6), 399–421.

Baldwin, J. H. (1997). Describes industrial design and reuse as precycling, Conservation. *Encarta Online Encyclopedia.* Retrieved from: http://www.encarta.msn.com

Borghi, A. D., Gallo, M., & Borghi, M. D. (2009). A survey of life cycle approaches in waste management. *The International Journal of Life Cycle Assessment*, *14*(7), 597–610. doi:10.100711367-009-0111-7

Boulding, K. (1966). The economics of the coming spaceship Earth. In H. Jarrett (Ed.), *Environmental quality in a growing economy, resources for the future* (pp. 3–14). Baltimore, MD: Johns Hopkins University Press.

Brezet, H., & Hemel, C. V. (1997). *ECODESIGN – A Promising Approach to Sustainable Production and Consumption*. Paris: UNEP.

BSI. (2008). *PAS 2050:2008, Specification for the Assessment of the Life Cycle Greenhouse Gas Emissions of Goods and Services*. Available at: http://www.bsigroup.com/en/Standards-andPublications/Industry-Sectors/Energy/PAS-2050/PAS-2050-Form-page/

Cheng, H., & Hu, Y. (2010). Municipal solid waste (MSW) as a renewable source of energy: Current and future practices in China. *Bioresource Technology*, *101*(11), 3816–3824. doi:10.1016/j.biortech.2010.01.040 PMID:20137912

Chertow, M. R. (2000). Industrial symbiosis: Literature and taxonomy. *Annual Review of Energy and the Environment*, *25*(1), 313–337. doi:10.1146/annurev.energy.25.1.313

City of Toronto. (2012). *How We Calculate Waste Diversion Rates*. Available: http://www.toronto.ca/environment/initiatives/wdt.htm

Colon, M., & Fawcett, B. (2006). Community-based household waste management: Lessons learnt from EXNORA's 'zero waste management' scheme in two South Indian cities. *Habitat International*, *30*(4), 916–931. doi:10.1016/j.habitatint.2005.04.006

Cox, J., Giorgi, S., Sharp, V., Strange, K., Wilson, D. C., & Blakey, N. (2010). Household waste prevention—A review of evidence. *Waste Management & Research*, *28*(3), 193–219. doi:10.1177/0734242X10361506 PMID:20215491

Curran, T., & Williams, I. D. (2012). A zero waste vision for industrial networks in Europe. *Journal of Hazardous Materials*, *207-208*, 3–7. doi:10.1016/j.jhazmat.2011.07.122 PMID:21899950

Davorin, K. (2011). Innovative systemic approach for promoting sustainable innovation for zero construction waste. *Kybernetes*, *40*(1/2), 275–289. doi:10.1108/03684921111118040

Dekker, R., Fleischmann, M., Inderfurth, K., & Wassenhove, V. (2003). *Reverse Logistics – Quantitative Models for Closed-Loop Supply Chains*. Berlin: Springer.

Ericson, S. (2010). No waste allowed. *Threads*, *149*, 60–63.

GAIA. (2013). *Individual Zero Waste Case Studies*. Available at http://no-burn.org/-1-18

Gillilan, S., Werner, C. M., Olson, L., & Adams, D. (1996). Teaching the concept of precycling: A campaign and evaluation. *The Journal of Environmental Education*, *28*(1), 11–18. doi:10.1080/00958964.1996.9942810

Grant, T., James, K.L., & Partl, H. (2003). *Life Cycle Assessment Of Waste Andresource Recovery*. Academic Press.

Greyson, J. (2007). An economic instrument for zero waste, economic growth and sustainability. *Journal of Cleaner Production*, *15*(13-14), 1382–1390. doi:10.1016/j.jclepro.2006.07.019

Guerrero, L. A., Maas, G., & Hogland, W. (2013). Solid waste management challenges for cities in developing countries. *Waste Management (New York, N.Y.)*, *33*(1), 220–232. doi:10.1016/j.wasman.2012.09.008 PMID:23098815

Hansen, M. S., & Gilberg, U. M. (2003). *Cost-benefit analysis and LCA in environmental decision-making – potentials and limitations* (Master thesis). E&R Technical University of Denmark, Kongens Lyngby.

Haro, P., Ollero, P., & Villanueva, A. L. (2013). Thermochemical biorefinery based on dimethyl ether as intermediate: Technoeconomic assessment. *Applied Energy*, *102*, 950–961. doi:10.1016/j.apenergy.2012.09.051

Hill, M. H., & Bucknell, P. A. (1967). *The evolution of fashion: Pattern and cut from 1066 to 1930*. London: Batsford.

Holmberg, J., & Robert, K. H. (2000). Backcasting from non-overlapping sustainability principles: A framework for strategic planning. *International Journal of Sustainable Development and World Ecology*, *7*, 291–308. doi:10.1080/13504500009470049

Iqbal, H. M. N., & Asgher, M. (2013). Characterization and decolorization applicability of xerogel matrix immobilized manganese peroxidase produced from Trametes versicolor IBL-04. *Protein and Peptide Letters*, *20*(5), 591–600. doi:10.2174/0929866511320050013 PMID:23016633

Iqbal, H. M. N., Kyazze, G., & Keshavarz, T. (2013). Advances in the valorization of lignocellulosic materials by biotechnology: An overview. *BioResources*, *8*(2), 3157–3176. doi:10.15376/biores.8.2.3157-3176

Jackson, T. (2005). *Motivating Sustainable Consumption: A Review of Evidence on Consumer Behaviour and Behavioural Change* (T. Jackson, Ed.). Surrey, UK: Sustainable Development Research Network.

JRC-IES. (2010). *International Reference Life Cycle Data System (ILCD) Handbook: General Guide for Life Cycle Assessment – Detailed Guidance (Plus 6 Supporting Documents)*. Author.

Karlsson, H., Ahlgren, S., Strid, I., & Hansson, P. A. (2015). Faba beans for biorefinery feedstock or feed? Greenhouse gas and energy balances of different applications. *Agricultural Systems*, *141*, 138–148. doi:10.1016/j.agsy.2015.10.004

King, S. (2004). *Strategic Framework—The Foundation of an Effective Planning Process*. Available online: http://www.infomanagementcenter.com/enewsletter/200411/third.htm

Kirkeby, J. T., Birgisdottir, H., Hansen, T. L., Christensen, T. H., Bhander, G. S., & Hauschild, M. (2006). Environmental assessment of solid waste systems and technologies: EASEWASTE. *Waste Management & Research*, *24*(1), 3–15. doi:10.1177/0734242X06062580 PMID:16496866

LaBrecque, S. (2015). What does zero waste mean to you? *The Guardian*.

Lambert, D. M. (2004). *Supply Chain Management: Processes, Partnerships, Performance* (1st ed.). Sarasota, FL: Supply Chain Management Institute.

Langeveld, H., Sanders, J., & Meeusen, M. (2012). *The Biobased Economy: Biofuels*. Materials, and Chemicals in the Post-oil Era, Earthscan.

Lansforsakringar Miljo. (2002). *Recycling Insurance*. Retrieved from http://www.lansforsakringar.se

Liao, C. H., & Chiu, A. S. F. (2011). Evaluate municipal solid waste management problems using hierarchical framework. *Procedia: Social and Behavioral Sciences*, *25*, 353–362. doi:10.1016/j.sbspro.2011.10.554

Matete, N., & Trois, C. (2008). Towards zero waste in emerging countrie Sea South African experience. *Waste Management (New York, N.Y.)*, *28*(8), 1480–1492. doi:10.1016/j.wasman.2007.06.006 PMID:17714928

McCormick, K., & Kautto, N. (2013). The bioeconomy in Europe: An overview. *Sustainability*, *5*(6), 2589–2608. doi:10.3390u5062589

McDougall, F. R., White, P., Francke, M., & Hindle, P. (2001). *Integrated Solid Waste Management – A Lifecycle Inventory 2*. London: Blackwell.

McQuillan, H. (2011). Zero-waste design practice: Strategies and risk taking for garment design. In A. Gwilt & T. Rissanen (Eds.), Shaping sustainable fashion: Changing the way we make and use clothes. London: Earthscan.

McQuillan, H., & Rissanen, T. (2011). *YIELD exhibition catalogue*. Brooklyn, NY: Textile Arts Center. Retrieved August 20, 2012, from http://yieldexhibition.com/yieldexhibitioncatalogue.pdf

Meadows, D. (1999). *Leverage points: places to intervene in a system*. Sustainability Institute. Retrieved from http://www.sustainabilityinstitute.org

Melanie, C., & Victoria, K. (2014). Expanding zero-waste design practices: A discussion paper, International Journal of Fashion Design. *Technology and Education*, *7*(1), 58–64. doi:10.1080/17543266.2013.837967

Murphy, S., & Pincetl, S. (2013). Zero waste in Los Angeles: Is the emperor wearing any clothes? *Resources, Conservation and Recycling*, *81*, 40–51. doi:10.1016/j.resconrec.2013.09.012

O'Rorke, M. (1988). *Public information campaign on precycling*. Prepared for City of Berkeley.

OECD. (2001). Extended Producer Responsibility: A Guidance Manual for Governments. Organization for Economic Cooperation and Development.

Palmer, P. (2004). *Getting to Zero Waste*. Sebastopol, CA: Purple Sky Press.

Parajuli, R., Dalgaard, T., Jørgensen, U., Adamsen, A. P. S., Knudsen, M. T., Birkved, M., & Schjørring, J. K. (2015). Biorefining in the prevailing energy and materials crisis: A review of sustainable pathways for biorefinery value chains and sustainability assessment methodologies. *Renewable & Sustainable Energy Reviews*, *43*, 244–263. doi:10.1016/j.rser.2014.11.041

Phillips, P. S., Tudor, T., Bird, H., & Bates, M. (2011). A critical review of a key waste strategy initiative in England: Zero waste places projects 2008-2009. *Resources, Conservation and Recycling*, *55*(3), 335–343. doi:10.1016/j.resconrec.2010.10.006

Pietrzak, W., Kawa-Rygielska, J., Król, B., Lennartsson, P. R., & Taherzadeh, M. J. (2016). Ethanol, feed components and fungal biomass production from field bean (Vicia faba var. equina) seeds in an integrated process. *Bioresource Technology*, *216*, 69–76. doi:10.1016/j.biortech.2016.05.055 PMID:27233099

Rex, E., & Baumann, H. (2008). Implications of an interpretive understanding of LCA practice. *Business Strategy and the Environment*, *17*(7), 420–430. doi:10.1002/bse.633

Rissanen, T. (2011). *Zero waste fashion repatterned exhibition catalogue*. Chicago, IL: Columbia College Chicago. Retrieved July 5, 2013, fromhttp://www.colum.edu/ADGallery/ Exhibits/2010_zerowaste/zerowastecatalog_final.pdf

Robinson, J. B. (1990, October). Future under glassda recipe for people who hate to predict. *Futures*.

Rogers, D. S., & Tibben-Lembke, R. S. (2001). An examination of reverse logistics practices. *Journal of Business Logistics*, *22*(2), 129–148. doi:10.1002/j.2158-1592.2001.tb00007.x

Rossem, C. V. (2008). *Individual producer responsibility in the WEEE Directive: from theory to practice?* (Ph.D. Dissertation). IIIEE, Lund University, Sweden.

Sakamoto, T., Hasunuma, T., Hori, Y., Yamada, R., & Kondo, A. (2012). Direct ethanol production from hemicellulosic materials of rice straw by use of an engineered yeast strain codisplaying three types of hemicellulolytic enzyme on the surface of xylose-utilizing Saccharomyces cerevisiae cells. *Journal of Biotechnology*, *158*(4), 4203–4210. doi:10.1016/j.jbiotec.2011.06.025 PMID:21741417

Scholey, D. V., Burton, E. J., & Williams, P. E. V. (2016). The bio refinery; producing feed and fuel from grain. *Food Chemistry*, *197*, 937–942. doi:10.1016/j.foodchem.2015.11.063 PMID:26617037

Seltenrich, N. (2017). *Incineration versus Recycling: In Europe, a Debate over Trash*. Available online:http://360.yale.edu/feature/incineration_versus_recycling__in_europe_a_debate_over_trash/2686/

Seng, B., Kaneko, H., Hirayama, K., & Katayama-Hirayama, K. (2010). Municipal solid waste management in Phnom Penh, capital city of Cambodia. *Waste Management & Research*, *29*(5), 491–500. doi:10.1177/0734242X10380994 PMID:20813763

Sentime, K. (2013). The impact of legislative framework governing waste management and collection in South Africa. *Afr. Geogr. Rev.*, *33*, 81–93.

Shahsavarani, H., Hasegawa, D., Yokota, D., Sugiyama, M., Kaneko, Y., Boonchird, C. H., & Harashima, S. (2013). Enhanced bio-ethanol production from cellulosic materials by semi-simultaneous saccharification and fermentation using high temperature resistant Saccharomyces cerevisiae TJ14. *Journal of Bioscience and Bioengineering*, *115*(1), 20–23. doi:10.1016/j.jbiosc.2012.07.018 PMID:22925900

Textiles Environment Design. (2012). *TED's Ten: 1 – design to minimise waste*. Retrieved October 26, 2012, from http://www.tedresearch.net/1-minimise-waste

The Carbon Trust. (2006). *Carbon Footprint in the Supply Chain: The Next Step for Business*. Author.

Thomas, S. (2008). From 'Green Blur' to ecofashion: Fashioning an eco-lexicon. *Fashion Theory*, *12*(4), 525–539. doi:10.2752/175174108X346977

Tojo, N. (2004). *Extended producer responsibility as a driver for design change – utopia or reality?* (Ph.D. Dissertation). IIIEE, Lund University, Sweden.

Townsend, K., & Mills, F. (2013). Mastering zero: How the pursuit of less waste leads to more creative pattern cutting. *International Journal of Fashion Design, Technology, and Education*, *6*(2), 104–111. doi:10.1080/17543266.2013.793746

UN-HABITAT. (2010). *Solid Waste Management in the World's Cities. Water and Sanitation in the World's Cities Report 2010*. Earthscan.

US EPA. (2008). *Introduction to the Concept of Green Chemistry*. Retrieved from http://www.epa.gov/oppt/greenchemistry/pubs/aboutgc.html

WRI-WBCSD. (2007). *The GHG Protocol for Project Accounting*. Author.

Wright, B. (1982). *The British Fire Mark 1680-1879*. Cambridge, UK: WoodheadFaulkner. Retrieved from http://www.firemarkcircle.fsnet.co.uk/history3.htm

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. doi:10.1016/j.jclepro.2014.12.013

Zaman, A. U. (2015). A Strategic Waste Management Framework and Tool for the Development of Zero Waste Cities. School of Art, Architecture and Design; University of South Australia.

Zaman, A. U., & Lehmann, S. (2011). Challenges and Opportunities in Transforming a City into a "Zero Waste City". *Challenges*, *2*(4), 73–93. doi:10.3390/challe2040073

Zaman, A. U., & 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. doi:10.1016/j.jclepro.2012.11.041

Zero Waste International Alliance. (2004). *Zero Waste Definition Adopted by Zero Waste Planning Group*. Retrieved from http://www.zwia.org/main/index.php?option=com_content&view=article&id=49&Itemid=37

Zero Waste SA. (2013). *South Australia's Waste Strategy 2011-2015*. Available at Error! Hyperlink reference not valid.

Zero Waste South Australia. (2013). *South Australia's Kerbside Three-Bin System Waste Report*. Retrieved from http://www.zerowaste.sa.gov.au/upload/resource-centre/publications/localgovernment/ZWSA%20Kerbside%20report%202015%20DE_02.pdf

ZWSA. (2011). *Zero Waste SA*. *About Us*. Available at http://www.zerowaste.sa.gov.au/about-us