Waste Management 67 (2017) 324–353

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Benefits, challenges and critical factors of success for Zero Waste: A systematic literature review

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ARTICLE INFO

Article history:
Received 15 December 2016
Revised 5 April 2017
Accepted 2 May 2017
Available online 29 May 2017

Keywords:
Waste management
Waste reduction
Waste mitigation
Recycling and reuse

ABSTRACT

Considering the growing concern with solid wastes problems and the pressing need for a holistic approach to their management, this study developed a literature review about the subject "Zero Waste". To that end, a systematic literature review was executed, through which 102 published articles were analyzed with the aim to, initially, comprehend the concept of Zero Waste, and, then, map its benefits, challenges, and critical success factors. The results show that scholars have not reached a consensus regarding the concept of ZW. While some studies fully address this philosophy, other studies are based on just one or on some of its topics. The benefits were grouped and organized into four dimensions: benefits to the community, financial-economic benefits, benefits to the environment and benefits to the industry and stakeholders. As to the challenges, barriers were identified both in the macro environment (mainly political and cultural) and in the meso and micro environments (stakeholders, industries, and municipalities). The analysis of the articles enabled listing critical success factors, supported by a set of activities that must be carried out. Regarding future studies, it is worth noting that more empirical studies about ZW implementation are necessary, particularly with regard to educational practices designed to promote changes in user behavior.

Contents

1. Introduction

Solid wastes have always been perceived as inevitable and undesirable, with heavy costs for final disposal. Historically solid waste management was shaped to serve a linear economy in which the production cycle covers the following stages: raw material extraction, manufacturing goods, sales, consumption, and disposal (Curran and Williams, 2012; Zaman, 2014a). In this scenario, more than 1.47 billion tons of solid wastes are annually generated worldwide (Zaman, 2016), which are mostly managed inefficiently (Wilson, 2006; Zaman, 2015), accounting for a premature ending of the useful life of many materials that would have some additional value for sale and/or recycling.

Statistically, while 84% of the solid wastes generated globally are collected, only 15% are recycled, and the major part is taken to landfills (Zaman, 2016). Punctually, according to data from Zaman and Swapan (2016), a person generates 435 kg of residues

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http://dx.doi.org/10.1016/j.wasman.2017.05.004
0956-053X/

a year, on average. Such data points to a significant problem, since inadequately stored solid waste promotes the emission of greenhouse gases, compromises water bodies, soils, vegetation, and public health (Sjöström and Östblom, 2010). In light of these facts, it is necessary to shift from the concept of a production process focused on a linear economy to the concept of a production process focused on a circular economy (Lehmann, 2011; Curran and Williams, 2012; Zaman, 2015). Circular economy aims to increase the efficiency of natural resource usage, especially on urban and industrial wastes (Ghisellini et al., 2016).

Recently, with the aim to guarantee sustainable growth, the European Union introduced a new directive concentrating efforts on this approach (EU 416/2015). Specifically, in order to facilitate the transition to a more circular economy, the document describes a set of policies with revised legislative proposals regarding wastes and a broad plan of action with a clear and ambitious long term orientation to increase recycling and reduce landfill disposal.

This means that planning the life cycle of the products should not be restricted to the point of disposal, but it should actually consider the reinsertion of solid wastes into new production processes (Rennings, 2000; Montalvo, 2003; Zaman and Lehmann, 2011), or the reuse in other possibilities (Strazza et al., 2015; Smol et al., 2016). Nevertheless, as described by Ghisellini et al. (2016), circular economy implementation still seems to be in its initial stages, majorly focused on recycling instead of reusing.

Waste management is highly inspired in the "solid waste hierarchy", a philosophy that prioritizes practices from waste prevention to the landfill. Neverthless, the solid waste hierarchy does not provide a sufficient background for waste and resource policy regarding the absolute reduction in material production, that is, zero waste (Gharfalkar et al., 2015; Ewijk and Stegemann, 2016). As a matter of fact, current environmental, social and economic demands focus on the identification of more efficient materials to be used in the transformation industry (Barrett and Scott, 2012; Shahbazi et al., 2016) and, besides that, it focuses on the adoption of a concept based on the waste's value, which should be converted into resources without, necessarily, reprocessing (Fudala-Ksiazek et al., 2016).

Thus, considering the pressing need for a holistic view for solid waste management, some researchers have provided scientific studies that encompass "Zero Waste (ZW)," a broader approach when compared to that described in the "solid waste hierarchy". According to Curran and Williams (2012), ZW refers to a unifying concept that embraces a series of measures that aim to eliminate waste and to challenge traditional thoughts. Mainly, ZW recognizes waste as a resource (Zaman, 2016), that is, it adopts a concept based on the value of the waste (Ewijk and Stegemann, 2016; Islam, 2017). Zaman (2015) highlights that, the concept of ZW is in constant development and being implemented in distinct sectors, such as waste treatment and management, mining, manufacturing, and urban development.

Nevertheless, academia does not provide a clear view on the ZW theme (Greyson, 2007; Curran and Williams, 2012; Zaman, 2016). Additionally, in the study of Zaman and Lehmann (2011), the authors highlight the challenge of operationalizing ZW-related actions. Still, there are theoretical overlaps regarding "life cycle management", "solid waste hierarchy" and "ZW" (Gharfalkar et al., 2015; Ewijk and Stegemann, 2016). In view of that, it is of latent need to proceed to a deeper analysis on the theme, especially regarding the implications of such policy (Silva et al., 2017). Thus, the present study, by means of a bibliographic review of the literature, aims to clarify the concept of ZW, identify benefits and challenges, as well as verify critical success factors related to the operationalization and the performance of ZW actions.

This article is organized in six sections. After this introduction, Section 2 presents the method used to develop this literature review. Section 3 describes the concept of ZW through distinct contributions mapped in the articles selected for the present study. Section 4 presents the benefits and challenges related to ZW, and lists the critical success factors identified in the researched literature. Section 5 lists critical success factors in the literature analyzed. Section 6 discusses the results and proposes future research in the area.

2. Method

To reach the objectives proposed in the introduction of this article, a literature review was executed, through a systematic analysis. This method was chosen for it mitigates the possibility of errors and it enables replicability (Mulrow, 1994). Following the instructions of Tranfield et al. (2003) and Moher et al. (2009), the development of the review involved five steps: (i) research objective definition; (ii) database selection; (iii) keyword identification; (iv) selection of compatible articles and (v) data extraction.

Regarding the (i) objective, this study aimed to comprehend the distinct concepts that are currently being used in academic papers for the ZW theme, their similarities, and contradictions, as well as the benefits, challenges, and critical success factors. As to (ii) database selection, the authors decided to search within the "*Science Direct*" *and "Web of Science*" databases. The (iii) keywords were searched through two steps: initially, only the term "zero waste" was searched for, which should be present in the titles, keywords and/or abstracts; afterwards with the aim to validate the robustness of the search, we conducted a new search on the "*Science Direct*" database through the Boolean operation (a: "landfill avoidance" OR "reduction" OR "mitigation"; AND b: "zero waste"), searching in "all fields". The type of document included in the search was "articles", and time limits were not defined.

The choice for an exclusive search on the "*Science Direct*" database is justified once that all the journals that contained the most selected articles in the first search are encompassed in this database (Waste Management, Journal of Cleaner Production and Resources, Conservation and Recycling, respectively). Quantitatively, the first search resulted in three hundred and nine articles (110 from the "*Science Direct*" database and 199 articles from the "*Web of Science*" database). Of the total, 83 articles were chosen, 26 of which were common among the platforms. Thus, 57 articles were initially selected. The second search generated a total of 511 articles. From this quantity, 149 articles were selected.

After the exclusion of the duplicates in both searches, (iv) the process of article selection started with the reading of the abstracts of the remaining articles, which was independently executed by more than one researcher, who were oriented to only select the articles that had research questions and results directly related to the objectives of this study. The entire sample was divided between the three researchers. At the end of this step, the set of publications to be used in the systematic review was reduced to 102 articles that effectively covered the issue (see Table 1 and Appendix A).

Afterwards, (v) the data extraction was carried out. To that end, the set of publications underwent a critical evaluation of the researchers. The verification focused on the identification of the concepts, benefits, challenges, and critical success factors of ZW. Finally, an aggregating approach was used to summarize the conclusions of the articles under review. Such an aggregative approach largely depends on the subjective interpretation of the researcher about the papers reviewed. This occurs because, as stated by Tranfield et al. (2003), a certain degree of subjective latitude must be given to the researcher so distinct studies can be compared and considered in order to extract shared meanings and abstract

Table 1
Selected articles.

Journal	Number of articles	Authors
Journal of Cleaner Production	28	Pauli (1997), Clay et al. (2007), Greyson (2007), Seadon (2010), Geng et al. (2013), McCormick et al. (2013), Uyarra and Gee (2013), Zaman and Lehmann (2013a), Mirabella et al. (2014), Zaman (2014b); Binnemans et al. (2015); Leigh and Li (2015), Song et al. (2015), Zaman (2015), Deus et al. (2016), Ewijk et al. (2016); Fischer and Pascucci (2016); Mourad (2016), Oliveira et al. (2016), Pitkänen et al. (2016), Shahbazi et al. (2016), Yazan et al. (2016), Zaman (2016), Zen et al. (2016); Zeng et al. (2016); Alwan et al. (2017), Beitzen-Heineke et al. (2017), Hutner et al. (2017)
Waste Management	21	Boyle (2000), Lu et al. (2006), Chang et al. (2008), Cherubini et al. (2008), Matete and Trois (2008); Shekdar (2009), Zotos et al. (2009), Timlett and Williams (2011), Zhang et al. (2011), Couth and Trois (2012), Scharff (2014), Farmer et al. (2015); Gutberlet (2015); Hottle et al. (2015), Wilson et al. (2015), Bufoni et al. (2016), Corvellec (2016), Fudala-Ksiazek et al. (2016), Silva et al. (2017), Ferreira et al. (2017); Yang et al. (2017)
Resources, Conservation and Recycling	14	McGrath (2001); Mason et al. (2003), Mason et al. (2004), Kelly et al. (2006), Haslenda and Jamaludin (2011), Phillips et al. (2011), Yoshida et al. (2012), Murphy and Pincetl (2013), Cole et al. (2014), Piippo et al. (2014), Meeks et al. (2015); Burlakovs et al. (2016), Priefer et al. (2016), Zaman and Swapan (2016)
Waste Management & Research	4	Snyman and Vorster (2010), Chang et al. (2013), Zaman and Lehmann (2013b), Bartl (2014)
Habitat International	3	Colon and Fawcett (2006), Permana et al. (2015), Ilic and Nikolic (2016)
Journal of Environmental Management	3	Li et al. (2015), Bratina et al. (2016), Smol et al. (2016)
Renewable and Sustainable Energy Reviews	3	Lu and Yuan (2013), Lim et al. (2014), Leo and Salvia (2017)
Bioresource Technology	2	Tsai (2008), Mohan et al. (2016)
Chemical Engeneering Journal	2	García-Serna et al. (2007), Chiang et al. (2014)
Ecological Indicators	2	Zaman (2014a), Chifari et al. (2016)
Marine Pollution Bulletin	2	Carman et al. (2015), Xanthos and Walker (2017)
Catalyses Today	1	Arntz (1993)
China Foundry	1	Torielli et al. (2010)
Cities	1	Warshawsky (2015)
City, Culture and Society	1	Zaman and Lehmann (2011)
Engineering Geology	1	Obuzor et al. (2012)
Food Policy	1	Halloran et al. (2014)
Futures	1	Fricker (2003)
Global Environmental Change	1	Barrett and Scott (2012)
Journal of Engeneering Manufacturing	1	Ball et al. (2009)
Journal of Hazardous Materials	1	Curran and Williams (2012)
Ocean & Coastal Management	1	Yeung (2001)
Procedia Social and Behavioral Sciences	1	Kulkarni et al. (2014)
Resource and Energy Economics	1	Matsueda and Nagase (2012)
Resources Policy	1	Tsai et al. (2007)
Science of The Total Environment	1	Islam (2017)
Sustainability	1	Lehmann (2011)
Sustainable Production and Consumption	1	Strazza et al. (2015)
Total	102	

approaches that do not address the declared purposes of the review.

3. Zero waste concept

Changing towards a more sustainable society requires greater sophistication in solid waste management. According to Seadon (2010), a reductionist approach cannot be sustained, thus, feedback circuits, focus on processes, adaptability and deviating waste from elimination are needed. In this scenario, the concept of circular economy gains ground, as well as a series of practices that aim to promote environmentally sustainable activities.

Theoretically, circular economy aims to increase resource use efficiency, with special focus on urban and industrial wastes (Ghisellini et al., 2016). Originated in the green economy and in the industrial ecology, its adequate implementation depends on all the actors of society (McCormick et al., 2013; Li et al., 2015; Permana et al., 2015). In sum, the concept of circular economy proposes that the resources extracted and produced be kept in circulation (Barrett and Scott, 2012). The idea, thus, is to perceive each material within a cyclical flow.

This context promoted the emergence of concepts and philosophies that guide academic papers, the elaboration of policies/guidelines and production and consumption activities (Murphy and Pincetl, 2013). Among these, due to similarities, confusions and overlaps, the present study will discuss: (i) life cycle management and assessment (LCA); (ii) solid waste hierarchy; and (iii) zero waste (ZW).

Regarding the (i) life cycle management and assessment (LCA), it aids the quantification of the environmental impacts by acting on the decision making throughout the design process (Ceschin and Gaziulusoy, 2016), and by promoting waste prevention on management systems in general (Gentil et al., 2011; Lu and Yuan, 2013). LCA can be an important tool for the consolidation and the improvement of companies' environmentally sustainable practices, once it analyzes products' properties, by verifying the proportion of the environmental impact in the different stages of the life and by seeking alternatives to solve or minimize them (Hertwich, 2005). LCA intends to reduce the use of toxic items, diminish water and energy consumption, reduce waste generation, find solutions to use wastes as byproducts, reduce costs within processes, assess machine and equipment usage, and still manage other environmental activities regarding the industrial process (Hertwich, 2005; Gmelin and Seuring, 2014).

Nevertheless, considering waste management, it can be stated that LCA acts in the micro and meso environments. That is, actions regarding the organization and the competitive environment are prioritized. However, to a transformative change, governance and planning in the macro levels can also occur, especially regarding political, cultural and behavioral aspects (Yeung, 2001; Lu et al., 2006; Matsueda and Nagase, 2012; McCormick et al., 2013;

Vaccari et al., 2013; Farmer et al., 2015; Li et al., 2015; Permana et al., 2015; Warshawsky, 2015; Beitzen-Heineke et al., 2017; Islam, 2017; Xanthos and Walker, 2017).

Another broadly discussed concept under the circular economy optics centers on the (ii) Hierarchy of Solid Wastes. This hierarchy encompasses a set of properties for waste management, systematizing practices that go from prevention to the sanitary landfill (Ewijk and Stegemann, 2016). Resource usage reduction, reuse, recycling, composting and final disposal in landfills are practices that integrate the management policy practiced by a series of municipalities that refer to the waste hierarchy (Oliveira et al., 2016; Ferreira et al., 2017). Nevertheless, the analysis of the studies that address this theory identifies a prioritization of the description of reduction and recycling initiatives, both in the activities performed by municipalities and in the activities performed by the industry (Chang et al., 2008; Couth and Trois, 2012; Halloran et al., 2014; Shahbazi et al., 2016; Zen et al., 2016; Alwan et al., 2017). Besides, according to Gharfalkar et al. (2015) some guidelines based on this concept present lack of operationalization clarity and overlaps of such practices as prevention, reduction, and reuse preparation. Still, waste hierarchy is considered for some researchers to be an insufficient basis for waste management policies, once it is not able to achieve the absolute reduction of material production (Curran and Williams, 2012; Ewijk and Stegemann, 2016).

In this sense, it is relevant to highlight that the new European Union Directives on waste management (EU 416/2015) legislates to the introduction of a zero waste strategy, in which wastes must be converted into resources (Fudala-Ksiazek et al., 2016). Despite being supported by the Solid Waste Hierarchy, the new directives are closer to the philosophy denominated by academic researches as (iii) Zero Waste (ZW).

Several academics propose different definitions for ZW. Furthermore, academia presents points of view both for and against the ZW approaches proposed (Bartl, 2011, 2014; Song et al., 2015; Zaman, 2015). Among the scholars that defend the philosophy, there is the understanding that it embraces the holistic management of wastes, acknowledging that these wastes are important resources to be reused (Greyson, 2007; Lehmann, 2011; Zaman, 2014a, 2014b; Hottle et al., 2015; Silva et al., 2017). However, the scope of studies on ZW is diverse, and the concept of zero waste is in constant development (Zaman, 2015).

The holistic implementation of ZW involves political view, the commitment of stakeholders and, technical and communicational capabilities (Zotos et al., 2009; Uyarra and Gee, 2013; Farmer et al., 2015; Mourad, 2016; Yazan et al., 2016). Scholars that defend ZW argue that the concept unifies a series of measures that aim to eliminate waste and to challenge traditional waste management systems (Colon and Fawcett, 2006; Shekdar, 2009; Curran and Williams, 2012). According to Cole et al. (2014), ZW encompasses waste prevention, high recycling levels, valuation of all resources originated from wastes, as well as behavioral changes. Fricker (2003) highlights that ZW sustainability is achieved through mimicry of nature's processes.

For Ewijk and Stegemann (2016), ZW involves a conception based on the value of wastes and other related collecting practices, stricter and more direct policies about less desirable options such as landfills, the specification of goals for waste management based on dematerialization ambitions. The ZW philosophy can be understood as broader than the concept of the solid waste hierarchy once it describes reasons for the inclusion of reuse in prevention, and, it also prioritizes recovery and reuse measures (Gharfalkar et al., 2015). According to Zaman and Swapan (2016) and Zaman (2016), the substitution of the demand for virgin material by means of zero waste activities generates a significant economy in waste production per year.

In sum, in the ZW philosophy, zero waste derives from the perception that waste must be understood as potential resource. Thus, in the practices oriented by this philosophy, wastes are values to be realized and not problems to be solved (Curran and Williams, 2012; Obuzor et al., 2012; Chang et al., 2013; Lim et al., 2014; Strazza et al., 2015; Bratina et al., 2016; Mohan et al., 2016; Smol et al., 2016; Leo and Salvia, 2017).

Finally, based on the definitions described, it is possible to propose the following key aspects for the ZW concept: (i) to manage wastes holistically; (ii) to develop guidelines/policies that address activities of smart planning of products and services; (iii) to communicate and educate citizens; (iv) to develop green supply chains; (v) to focus on material efficiency in raw material selection; (vi) to plan and insert in the market products with extended lifetime; (vii) to invest in technologies for the adequate management of sanitary landfills.

Building on the analysis presented above, it is possible to affirm that of the 102 selected articles, only 31 approach the concept discussing the holistic view of the ZW through practices of macro, meso and micro levels. The others 71 articles cover a part or a fragment of the ideas related to the concept, promoting efficiency or productivity of resources, describing new technologies to align productive processes with the ZW philosophy, showing solutions for waste post-generation, detailing technologies or means for recycling and/or reuse, and presenting tools to evaluate the impact of different actions related to waste management. The use of ZW concept is summarized in Fig. 1.

4. Benefits and challenges for implementing the ZW philosophy

Initially, referring to the content of the publications regarding the benefits of the ZW philosophy, the variables mapped were grouped into four dimensions: (i) benefits to the community; (ii) economic and financial benefits; (iii) environmental benefits; and (iv) specific benefits for industries and their stakeholders.

Concerning the (i) benefits to the community, there is an incentive for citizen commitment to help implement ZW, complemented by changes in people's lifestyle about consumption patterns and attitudes on waste disposal. Moreover, the implementation of ZW-related practices significantly minimizes the risks to public health, and enables an increase in job offers by recycling and usage practices and by the opening and consolidation of waste collection and separation cooperatives.

As to the (ii) economic and financial benefits, the sampled articles enabled the identification of: cost reduction and consequent increase in the profits (related to the waste collection and disposal systems for solid wastes in the municipalities), since less waste is generated and they are segregated at the source; prevention of costs of environmental restoration and losses related to process inefficiency; increase in profits from the sales of recycled materials. Another economic benefit of ZW implementation focuses on the increase of income flow, which derives from the job offers associated to this system.

Regarding the (iii) benefits to the environment, eight advantages were compiled: reduction of waste generation and its negative impacts; extension of the useful life of sanitary landfills; increased efficiency in using raw materials and reduction of virgin raw material extraction; reduction of the emission of greenhouse gases; opportunity to produce energy through wastes and/or the sale of carbon credits; reduction of energy consumption because of the higher ecoefficiency of the production and recycling processes; increased environmental protection; and reduction of the use of toxic materials in the products.

Lastly, five benefits were identified for (iv) industries and their stakeholders: improved efficiency and productivity - producing

Articles that discussing the holistic view of ZW	
	Boyle (2000); Yeung (2001); Mason et al. (2003); Mason et al. (2004); Tsai et al. (2007); Chang et al. (2008); Matete and Trois (2008); Zotos et al. (2009); Lehmann (2011); Phillips et al. (2011); Zaman and Lehmann (2011); Zhang et al. (2011); Chang et al. (2013); Geng et al. (2013); Uyarra and Sally (2013); Cole et al. (2014); Carman et al. (2015); Meecks et al. (2015); Song et al. (2015); Bufoni et al. (2016); Ewijk et al. (2016); Ilic and Nikolic (2016); Mourad (2016); Pitkänen et al. (2016); Silva et al. (2017); Zeng et al. (2016); Alwan et al. (2017); Beitzen-Heineke et al. (2017); Hutner et al. (2017); Leo and Salvia (2017); Xanthos and Walker (2017)
Articles that cover only a fragment of the ideas related to the ZW concept	
Efficiency or productivity of resources	Pauli (1997); Fricker (2003); Greyson (2007); Seadon (2010); Barret and Scott (2012); Lu and Yuan (2013); Murphy and Pincetl (2013); Leigh and Li (2015); Li et al. (2015); Zaman (2015); Fisher and Pascucci (2016); Priefer et al. (2016); Shahbazi et al. (2016); Yazan et al. (2016)
New technologies to productive processes	Arntz (1993); Pauli (1997); Greyson (2007); Ball et al. (2009); Shekdar (2009); Seadon (2010); Torielli et al. (2010); Haslenda and Jamaludin (2011); Curran and Williams (2012); Lu and Yuan (2013); McCormick et al. (2013); Kulkarni et al. (2014); Li et al. (2015); Zaman (2015); Fisher and Pascucci (2016); Yang et al. (2017)
Solutions for post-generation waste	Colon and Fawcett (2006); Kelly et al. (2006); Snyman and Vorster (2010); Yoshida et al. (2012); Bartl (2014); Lim et al. (2014); Scharff (2014); Binnemans et al. (2015); Farmer et al. (2015); Gutberlet et al. (2015); Permana et al. (2015); Warshawsky (2015); Zaman (2015); Burlakovs et al. (2016); Fudala-Ksiazek et al. (2016); Oliveira et al. (2016); Zen et al. (2016)
Technologies or means for recycling and/or reuse	Lu et al. (2006); Clay et al. (2007); Greyson (2007); Tsai (2008); Shekdar (2009); Seadon (2010); Haslenda and Jamaludin (2011); Timlett and Williams (2011); Couth and Trois (2012); Curran and Williams (2012); Matsueda and Nagase (2012); Obuzor et al. (2012); McCormick et al. (2013); Chiang et al. (2014); Halloran et al. (2014); Kulkarni et al. (2014); Mirabella et al. (2014); Piippo et al. (2014); Li et al. (2015); Permana et al. (2015); Strazza et al. (2015); Warshawsky (2015); Zaman (2015); Bratina et al. (2016); Deus et al. (2016); Mohan et al. (2016); Priefer et al. (2016); Smol et al. (2016); Yazan et al. (2016); Zen et al. (2016); Yang et al. (2017)
Tools to evaluate performance in waste management	McGrath (2001); García-Serna et al. (2007); Cherubini et al. (2008); Curran and Williams (2012); Zaman and Lehmann (2013a; 2013b); Zaman (2014a; 2014b); Hottle et al. (2015); Wilson et al. (2015); Chifari et al. (2016); Corvellec (2016); Oliveira et al. (2016); Zaman (2016); Zaman and Swapan (2016); Ferreira et al. (2017); Islam (2017)

Fig. 1. Use of ZW concept in selected articles.

more with less; improved product design to extend life cycle; increment of companies' competitive potential through customer satisfaction and increased reliability; incentive to the elaboration of a sustainable chain of suppliers; and industrial symbiosis practices, where companies provide their wastes to other companies and vice versa.

Fig. 2 summarizes the benefits mapped in the review.

With regard to the challenges related to ZW implementation, the analysis of the articles initially aimed to identify actions that demand significant efforts of the distinct actors involved in the process, strategic changes or restructuring processes. The second issue observed for grouping in this topic refers to the barriers described in the studies, both the barriers that limit its applicability as well as those that deter the execution of projects. As the result of the analysis performed, 20 challenges were listed, which are hereafter described and summarized in Fig. 3. It is important to highlight that the summarization considered the environments that support the holistic implementation of the ZW philosophy: (i) macro, (ii) meso and (iii) microenvironment.

In the (i) macroenvironment, the external variables that present the most challenges concern political, cultural, economic, and technological issues, respectively. Politically, a set of studies highlight the importance of the existence of mandatory waste management guidelines, strong policy maker's commitment and support to environmental sustainability issues, the review of sociopolitical constraints, and the creation of a consistent database for performance comparison between cities.

As to the cultural challenges, it must be highlighted that it is difficult to change the consumption patterns and behavior of citizens when dealing with environmental problems. In addition to this,

Dimensions	Variables	Authors
Benefits to the community	Incentive for citizen commitment to help implement ZW	Chang et al. (2008); Phillips et al. (2011)
	Changes in people's lifestyle	Song et al. (2015); Mourad (2016); Priefer et al. (2016); Beitzen-Heineke et al. (2017); Xanthos and Walter (2017)
	Minimization of public health risks	Tsai (2008); Halloran et al. (2014); Strazza et al. (2015); Bratina et al. (2016)
	Increase in job offers	Murphy and Pincetl (2013); Lim et al. (2014); Piippo et al. (2014); Gutberlet, (2015); Li et al. (2015); Song et al. (2015); Zaman (2015); Mourad (2016)
Economic and financial benefits	Cost reduction and consequent increase in the profits	Matete and Trois (2008); Uyarra and Gee (2013); Chifari et al. (2016); Oliveira et al. (2016)
	Prevention of costs of environmental restoration and losses related to process inefficiency	Clay et al. (2007); Ferreira et al. (2017)
	Increase in profits from the sales of recycled materials	Chang et al. (2008)
	Increase of income flow	Murphy and Pincetl (2013); Song et al. (2015); Zaman (2015)
Benefits to the environment	Reduction of waste generation and its negative impacts	Tsai (2008); Torielli et al. (2010); Murphy and Pincetl (2013); Kulkarni et al. (2014); Piippo et al.(2014); Zaman, (2014b); Fudala-Ksiazek et al. (2016); Lu et al. (2016); Shahbazi et al. (2016)
	Extension of the useful life of sanitary landfills	Colon and Fawcett (2006); Matete and Trois (2008); Snyman and Vorster (2010); Lim et al. (2014); Burlakovs et al. (2016)
	Increased materials efficiency and reduction of extraction	Clay et al. (2007); Lehmann (2011); Curran and Williams (2012); Zaman and Swapan (2016)
	Reduction of the emission of greenhouse gases	Cherubini et al. (2008); Phillips et al. (2011); Lim et al. (2014); Hottle et al. (2015); Islam (2017)
	Opportunity to produce clean energy	Cherubini et al. (2008); Snyman and Vorster (2010); Uyarra and Gee (2013); Zaman and Lehmann (2013a and 2013b); Lim et al. (2014); Hottle et al. (2015)
	Reduction of energy consumption	Seadon (2010); Torielli et al. (2010); Bartl (2014)
	Increased environmental protection	Murphy and Pincetl (2013)
	Reduction of the use of toxic materials in the products	Lehmann (2011); Barret and Scott (2012); Shahbazi et al. (2016); Silva et al. (2017)
Benefits for industries and their stakeholders	Improved efficiency and productivity	Pauli (1997); Clay et al. (2007); Barret and Scott (2012); Curran and Williams (2012); Obuzor et al., (2012); Lu and Yuan (2013)
	Improved product design to extend life cycle	Zaman and Lehmann (2011); Curran and Williams (2012)
	Increment of companies' competitive potential	Torielli et al. (2010); Curran and Williams (2012)
	Incentive to the elaboration of a sustainable chain of suppliers	Lehmann (2011); Li et al. (2015); Fischer and Pascucci (2016)
	Industrial symbiosis practices	Haslenda and Jamaludin (2011); Curran and Williams (2012); Leigh and Li (2015); Strazza, et al. (2015); Fischer and Pascucci (2016); Yazan et al. (2016)

Fig. 2. Benefits from the implementation of "Zero Waste".

some trends in social changes such as greater prosperity and purchasing power of the population, smaller families, and the insertion of women in the labor market were also mapped. In this way, it is necessary to promote permanent and efficient communication and education. Also, it takes time to adapt the population to the new strategies.

Regarding the economic aspects, it is relevant to highlight that the agreements that regulate taxation and discounts must be adequately planned considering the taxes to monitor and to control the impact of wastes after their generation. High taxes on solid waste discharge in local landfills, for example, would encourage the diversion of the wastes to farther landfills. Finally, the regulation of a market to sell and purchase wastes becomes a challenge insofar as the recycling process will only take place if it is financially advantageous.

Technological aspects refer to the need for investments in the development of researches that improve waste management technologies, as well as their dissemination. Technological constraints constitute a strong barrier for the dissemination of ZW related actions in distinct regions, countries, and market segments. Technology is a key aspect for leveraging waste management changes, especially regarding material efficiency increase. In the (ii) meso and (iii) microenvironments, composed by stakeholders and industry/municipalities, the lack of understanding about ZW was mapped, which is a barrier to the development of this holistic view. According to articles analyzed, the difficulty in rendering ZW operational is related to the perception of high costs, with the complexity related to its implementation and the lack of knowledge among the professionals involved. In addition, there is the difficulty in articulating the stakeholders so as to provide a real sustainable chain of suppliers and a circular economy.

In operationalizing solid waste management, the difficulties are the feasibility of recycling and the repair of products, since the laws of thermodynamics limit the amount of times a material can be recycled, besides the fact that hazardous substances, and the diversity in material composition make recycling difficult. Furthermore, it is true that redesigning the products requires an understanding of the entire life cycle of the product, which few companies have. Finally, the following practices are necessary for the industry and the municipalities to implement ZW: the total elimination or expressive reduction of waste generation; the suppression of incineration and disposal in sanitary landfills; the adequate management of hazardous wastes, which demands planning from the political and private actors; and innovation and investment in the redesigning of products to avoid toxicity and promote products that will truly be more ecological.

5. Critical success factors for "Zero Waste

Critical success factors in this study are considered essential practices for the effective and efficient ZW implementation. Initially, a substantial change in citizens' behavior and consumption patterns is necessary, in order to attain success, which must meet environmental needs (Phillips et al., 2011; Zaman and Lehmann, 2013b). Conducting programs and campaigns on environmental education to sensitize adults and children and informing them about the correct means to segregate and dispose of wastes is mandatory (Mason et al., 2003; Zotos et al., 2009; Zhang et al., 2011; Geng et al., 2013; Uyarra and Gee, 2013; Halloran et al., 2014; Priefer et al., 2016; Silva et al., 2017; Zen et al., 2016; Xanthos and Walker, 2017). Furthermore, it is essential for people to be involved and engaged in these activities in order to be able to attain the solid waste management goals, since citizens are co-responsible for the generation and disposal of their wastes (Yeung, 2001; Lu et al., 2006; Tsai et al., 2007; Zaman, 2014a;

Environmental levels	Challenges	Authors
Macroenvironment	**Political variables**	
	Need for mandatory waste management guidelines and policies for economic blocks, countries and municipalities	Lu et al. (2006); Tsai (2008); Lehmann (2011); Matsueda and Nagase (2012); Carman et al. (2015); Warshawsky (2015); Fudala-Ksiazek et al (2016); Ilic and Nikolic (2016); Priefer et al. (2016); Islam (2017)
	Strong policy maker's commitment and support to environmental sustainability issues	Uyarra and Gee (2013); Cole et al. (2014); Zaman (2014a); Farmer et al. (2015); Permana et al., (2015); Silva et al. (2017); Xanthos and Walker (2017)
	Review of sociopolitical constraints	Bufoni et al. (2016)
	Creation of a consistent database for performance comparison between cities	Zaman and Lehmann (2013a); Zaman (2014b); Wilson et al. (2015); Zaman (2016).
	Cultural/behavioral variables	
	Change the consumption patterns and behavior of citizens	Chang et al. (2008); Timlett and Williams (2011); Zaman (2014a); Li et al. (2015); Meeks et al. (2015); Corvellec (2016); Priefer et al. (2016)Silva et al. (2017); Hutner et al. (2017)
	Promote permanent and efficient communication and education about waste reduction	Yeung (2001); Mason et al. (2004); Uyara and Gee (2013); Halloran et al. (2014); Carman et al. (2015); Permana et al. (2015); Beitzen-Heineke et al. (2017); Hutner et al. (2017); Xanthos and Walker (2017)
	The time to adapt the population to the new strategies	Snyman and Vorster (2010); Lehmann (2011).
	Economic Variables	
	Agreements that regulate taxation and discounts must be adequately planned	Lu et al. (2006); Zaman (2014a); Scharff (2014); Ferreira et al. (2017); Xanthos and Walker (2017)
	Regulation of a market to sell and purchase	Chang et al. (2013); Lehmann (2011)
	Technological variables	
	Need for investments in the development of researches that improve waste management technologies, as well as their dissemination	Bufoni et al. (2016); Ilác and Nikolic (2016); Silva et al. (2017); Alwan et al. (2017)
	Expand research and investment in efficient materials technologies	Seadon (2010); Barret and Scott (2012); Obuzor et al. (2012); Bratina et al. (2016); Corvellec (2016); Shahlazi et al. (2016); Silva et al. (2017)
Meso and Microenvironment	Perception of high costs for implementation	(Zaman, 2014a; Zotos et al., 2009; Shahbazi et al., 2016; Alwan et al., 2017).
	Lack of technical knowledge, proactivity and leadership of the professionals involved	(Zaman, 2014a; Warshawsky, 2015; Mourad, 2016; Shahbazi et al., 2016; Alwan et al., 2017).
	Articulate stakeholders for the real development of a green supply chain	Colon and Fawcett (2006); Haslenda and Jamaludin (2011); Yoshida et al., (2012); Fischer and Pascucci (2016); Zeng et al. (2016).
	Feasibility of recycling and the repair of products	Greyson (2007); Song et al. (2015)
	Understanding of the entire life cycle of the product	Chang et al. (2013)
	Total elimination or expressive reduction of waste generation	Boyle (2000); Cole et al. (2014)
	Suppression of incineration and disposal in sanitary landfills	Zaman (2014a and 2014b)
	Adequate management of hazardous wastes	Zotos et al. (2009)
	Innovation and investment in the redesigning of products	García-Serna et al. (2007); Kulkarni et al. (2014)

Fig. 3. Challenges from the implementation of "Zero Waste".

Carman et al., 2015; Gutberlet, 2015; Permana et al., 2015; Corvellec, 2016; Silva et al., 2017; Hutner et al., 2017).

In addition, the holistic implementation of the ZW should promote public–private partnerships, in such a way as to achieve effective cooperation among the various stakeholders and the environmental benchmarking among these actors (Zotos et al., 2009; Phillips et al., 2011; McCormick et al., 2013; Pitkänen et al., 2016). In addition, the support and commitment of politicians and public administrators for the implementation of ZW (Geng et al., 2013; Uyarra and Gee, 2013; Lim et al., 2014; Carman et al., 2015; Permana et al., 2015; Deus et al., 2016), as well as significant changes in public policies (Clay et al., 2007; Matsueda and Nagase, 2012; Cole et al., 2014; Zaman, 2014a; Warshawsky, 2015; Fudala-Ksiazek et al., 2016; Priefer et al., 2016; Leo and Salvia, 2017; Islam, 2017), are very important.

Regulation of rates and financial incentives are also necessary, since these are variables acknowledged to be used as instruments that incentivize the diversion of the solid wastes from sanitary landfills (Phillipis et al., 2011). Specialists advocate for the implementation of charging systems, because they believe these systems will enable product recycling feasible post-consumption. These systems may demand that the consumers pay on the amount of wastes that they generate (*pay-as-you-throw*) (Zotos et al., 2009; Timlett and Williams, 2011; Priefer et al., 2016), or that manufacturers and importers of products pay a rate on every unit sold, so as to make it possible to collect and recycle them when they are discarded by the consumers (*Recycling Fund Management* - RFM) (Chang et al., 2008). Further, the studies advocate for rates and taxes reduction for products and processes that are proved to use clean technologies (Boyle, 2000), and fines to penalize illegal actions in solid waste management (Chang et al., 2013; Priefer et al., 2016). Another action for ZW efficacy focuses on establishing a market for the waste, since it makes the sale and purchase of wastes economically feasible (Zaman, 2014a; Yazan et al., 2016). Also, according to Zaman (2014a), one must regulate the export and import of solid wastes, since the high labor and recovery costs have a negative impact on the economic and environmental resources of the receiving countries.

Further activities for the successful implementation of the ZW philosophy include extending the responsibility of the producers, also known as reverse logistics (Lu et al., 2006; Zaman and Lehmann, 2011; Beitzen-Heineke et al., 2017), organization of companies in a cluster or symbiosis (so as to redirect the flow of materials, energy and wastes from one industry to another) (Pauli 1997; Ball et al., 2009; Haslenda and Jamuludin, 2011; Curran and Williams, 2012; Mirabella et al., 2014; Leigh and Li, 2015; Meeks et al., 2015; Fischer and Pascucci, 2016; Yazan et al., 2016), and promotion of a sustainable chain of suppliers (Ball et al., 2009; Lehmann, 2011; Hottle et al., 2015; Li et al., 2015; Zeng et al., 2016).

A series of contributions also indicates that the development of academic research on cleaner technologies and/or recycling alternatives is significantly important, and must be adequately disseminated among municipalities and industries (Mason et al., 2003; Zaman and Lehmann, 2011; Chiang et al., 2014; Bratina et al., 2016; Deus et al., 2016; Mohan et al., 2016; Parashar et al., 2016; Silva et al., 2017; Smol et al., 2016). Beyond the universities, the promotion of investments in technological and infrastructural

innovation is important both for industry and for municipalities (Lehmann, 2011; Curran and Williams, 2012; Pitkänen et al., 2016).

As to the success for ZW implementation, it is also necessary product redesigning (Lehmann, 2011; Binnemans et al., 2015; Zaman, 2015), as well as prioritize the use of renewable raw materials (Arntz, 1993; García-Serna et al., 2007; Barrett and Scott, 2012; Strazza et al., 2015; Shahbazi et al., 2016). Still, municipalities and industries should map the flow of solid wastes and the quantities of wastes generated for the appropriate planning of goals, investments, structure of the solid waste management system (Mason et al., 2004; Geng et al., 2013; Murphy and Pincetl, 2013; Wilson et al., 2015), and forecast of demand for the collection system, transport, recycling, and final disposal (Zaman and Lehmann, 2011). Another relevant factor refers to the need for continuous process monitoring by the use of tools for environmental performance evaluation (Boyle, 2000; McGrath, 2001; Zaman, 2014a, 2014b; Chifari et al., 2016; Oliveira et al., 2016).

Considering the above, we understand that the critical success factors for the implementation of the ZW can be organized into two groups: (i) governance and planning, and (ii) operationalization. Also, add the barriers verified and presented in the previous section to the analysis of the actions described in the literature for success, the authors propose, through Fig. 4, alternatives to execute activities concerning the success drivers.

6. Discussion and research agenda

The impacts of economic development include the depletion of natural resources, overconsumption, pollution, and their impact on biodiversity and ecosystems (Hart and Milstein, 2003). In this scenario, governments and organizations have latent concern when faced with the increasing volume of solid waste as well as the way it is managed (Sharholy et al., 2007; Seng et al., 2010; Lehmann, 2011).

Given the above, and considering that the linear economic point of view has become unsustainable in the long term, since it accelerates the depletion of resources and prevents recyclable materials from being inserted in other production processes, investment in more sustainable management practices has become essential (Curran and Williams, 2012; Zaman, 2014b). Therefore, given the need to redesign product life cycles to mitigate their environmental impacts, and the need for product designs focused on reducing waste generation, and the reintegration of waste that could not be avoided into new production processes, a series of studies have addressed the Zero Waste (ZW) philosophy.

Considering the selection of articles carried out to develop the present study, we can say that the topic of ZW has been gaining importance in academic research on solid waste management, insofar as the number of articles published is growing. There was a significant increment in recent years (71% of the publications analyzed in the present study occurred between 2012 and 2017). Observing the academic work conducted on this topic, it was possible to generate two classifications: "Cities/Places" - when the study object focuses on the management of urban solid wastes, which may involve research performed in municipalities, neighborhoods, universities, fairs and local events and others; and "Business", when the object focuses on the wastes of industry, commerce or other private institutions. Also, analyzing the techni-

	Critical Sucess Factors	Ways to Done
Governance and Planning	Substantial change in the citizens' behavior and consumption	Engage citizens in the activities of reducing and disposing by communication and signaling (public-private partnerships)
		Create educational programs in schools, communities and universities (public-private partnerships)
		Provide citizens alternatives for waste disposal (public-private partnerships)
		Promote services / products for collaborative consumption ((public-private partnerships)
		Scone inappropriate behavior in relation to disposal of waste (public)
	Regulation of rates and financial incentives	Require that consumers pay for the waste they generate (public)
		Cash a rate on each product sold to be paid by manufacturers and importers (public)
		Reduce taxes and fees for cleaner products and processes (public)
		Regulate the import and export of waste (public)
	Modifications in the logistics system	Invest in reverse logistics activities (public-private partnerships)
		Prioritize the development of nearby and green chains (public-private partnerships)
		Organization of companies in a cluster or symbiosis (private)
	Promote green innovation	Encourage research on new technologies that are environmentally sustainable (public-private partnerships)
		Develop extension activities to promote innovations created and tested in universities (public-private partnerships)
Operationalizing	Products redesigning	Improve the design to extend the useful life of the products (private)
		Eliminate toxicity in the composition of products (private)
		Invest in the supply of products developed through the Design for Sustainable Behavior (private)
		Prioritize the use of renewable raw material
	Qualify infrastructure of industries and municipalities	Use tools to assess environmental performance
		Invest in labor training
		Invest in new technologies

Fig. 4. Critical Success Factors for "Zero Waste".

cal procedure employed in the studies sampled, it is possible to affirm that the case studies are the technique most used, followed, respectively, for qualitative and quantitative research, literature reviews, and the development and application of evaluation tools.

The implementation of ZW requires a holistic point of view, either for the strategic changes needed within organizations that wish to put it into operation (Curran and Williams, 2012), or for its practice in city management (Zaman and Lehmann, 2011; Cole et al., 2014). In addition, roles and competencies of different stakeholders should be described and widely communicated (Boyle, 2000; Zotos et al., 2009; Li et al., 2015), improvements to infrastructure and services should be put into operation by focusing on ways to promote behavioral changes (Timlett and Williams, 2011; Geng et al., 2013), and an analysis of local resources and their contexts should be done (Colon and Fawcett, 2006; Snyman and Vorster, 2010).

In this sense, the selected articles allow us to highlight some examples: Uyarra and Gee (2013) study describes how a city in the United Kingdom has undergone an environmentally sustainable transformation, changing from a simple landfill model to a highly technological and complex waste solution, based on intensive recycling, composting and sustainable energy use; Chang et al. (2013) present successful practices for Solid Waste Management in Taiwan, highlighting recycling management programs, which include Mandatory Refuse Sorting and Recycling, Diverse Bulk Waste Reuse, Pay-as-you Discharge, Total Food Waste Recycling, Restricted Use on Plastic Shopping Bags & Plastic Tableware, Recycling Fund Management, and Ash Reuse; Matate and Trois (2008) describe a zero waste model for post-consumer waste in urban communities, tested and successful in two cities of South Africa; Yazan et al. (2016) details two successful cases of industrial symbiosis in a tannery district. Obuzor et al. (2012) confirmed the feasibility of the use of residual materials in the stabilization of low support clayey soils; Smol et al. (2016) presents the possibility of using ashes of sewage sludge generated by incineration as a secondary source of phosphorus.

Fundamentally, as shown by the systematization performed by Zaman (2015), the development of strategies that can operationalize ZW include: prevention in the process; prevention focused on sustainable consumption and behavior; and waste reduction. Additionally, according to Fricker (2003), Tsai (2008), Obuzor et al. (2012), Strazza et al. (2015), Bratina et al. (2016), and Ewijk and Stegemann (2016), ZW implementation depends on a concept based on the value of wastes. The work developed by Arntz (1993), Pauli (1997), Kelly et al. (2006), Clay et al. (2007), García-Serna et al. (2007), Chang et al. (2008), Ball et al. (2009), Barrett and Scott (2012), Binnemans et al. (2015), and Shahbazi et al. (2016), discuss the relevance of technological and design practices for production processes to be more efficient and effective in relation to the generation of solid waste. Meanwhile, Yeung (2001), Mason et al. (2003), Greyson (2007), Kelly et al. (2006), Tsai et al. (2007), Matate and Trois (2008), Phillps et al. (2011), Murphy and Pincetl (2013), Halloran et al., (2014), Priefer et al. (2016), Beitzen-Heineke et al. (2017) and Hutner et al. (2017), confirm how important changes in user behavior are for the success of the actions related to ZW, where educational campaigns throughout the process are essential. Finally, Lu et al. (2006), Scharff (2014), Farmer et al. (2015), Warshawsky (2015), and Oliveira et al. (2016), point out that legislation coupled with efficient management of resources can also be a relevant factor for waste reduction.

However, according to Bartl (2014) and Bufoni et al. (2016), there are some factors that inhibit reduction practices, such as conflicts of interest, economic growth, measurement mechanisms, and consumer demand for products with greater durability. In fact, greater reduction, increased adoption of recycled products and byproducts, as well as greater involvement in processes as composting or the adoption of zero packaging strongly depends on the behavior of policy makers, researchers, industries, retailers, suppliers, and users (Halloran et al., 2014; Silva et al., 2017; Beitzen-Heineke et al., 2017).

Warshawsky (2015), Mourad (2016), Shahbazzi et al. (2016), and Alwan et al. (2017) highlight the importance of effective leadership in the macro, meso and micro levels (government, society, associations, NGOs, suppliers, intermediaries, and industries), otherwise, the percentage of recycling, reuse and usage of more efficient materials will continue to be inappropriate. Geng et al. (2013) proposed an integrated model on green university and employed a case study approach that showed that the success of waste management depends on close collaboration with the local government, and also on one comprehensive plan so that all the stakeholders can join it and more resources can be gained to support its implementation. In addiction, Zeng et al. (2016) finding that institutional pressure has a significant positive impact on supply chain relationship management and sustainable supply chain design.

Zotos et al. (2009), Uyarra and Gee (2013) and Wilson et al. (2015) emphasize that the implementation of ZW in cities, regions or countries depends on the competency of the local administrators regarding the identification, collection, monitoring and assessment of relevant data, nevertheless, this capability is often inadequate. Additionally, Farmer et al. (2015) state that strategy and clear national coordination are key to orient policies, practices, and investments in infrastructure. Li et al. (2015) point to the urgent need to develop and disseminate green technologies in existing facilities, especially in developing countries, so green supply chains can be created and expanded. Meeks et al. (2015), in a study that aimed to analyze the use of compostable biopolymers by distinct stakeholders in the USA, identified that the intermediaries' purchase decisions are directly related to each organization's sustainability goals, as well as to the waste infrastructure available.

Moreover, ZW practice depends on further development of governmental policies (Ilic and Nikolic, 2016; Silva et al., 2017). For example, although the current European Union Directive (EU 416/2015) presents significant rules to align waste management with a smart, sustainable and inclusive growth, approaching it to the conceptual definitions described in academic works for the ZW philosophy, other countries and/or groups of countries still present a set of rules based on the solid waste hierarchy (as a result, these waste management actions present excessive focus on recycling in spite of prevention and reuse actions) (Ewijk and Stegemann, 2016; Islam, 2017).

In sum, according to a study developed by Zaman (2014a), there are seven distinct domains for the successful management of ZW: (i) location; (ii) management; (iii) socio-cultural characteristics; (iv) environmental issues; (v) economic issues; (vi) organizations; and (vii) governance and policy. For Kulkarni et al. (2014) and Song et al. (2015), ZW management success not only requires appropriate technologies, but also social, economic, and political variables that are appropriate for its implementation. Ilic and Nikolic (2016) highlight that successful waste management is associated to society's economic, social, and political factors.

Regarding future studies, it is worth noting that more empirical studies about ZW implementation are necessary (Song et al., 2015), particularly regarding educational practices designed to promote changes in user behavior (Matate and Trois, 2008; Murphy and Pincetl, 2013). In fact, although the studies developed by Abrahmse and Steg (2013) and Sussman et al. (2013) have verified that human models, more than visual communication, can positively influence supportive behavior for environmentally sustain-

able practices, learning about motivation mechanisms for behavioral change still remains a latent need. Such need is justified once that in a capitalist economy, the principles, values, and behaviors of a large portion of the population are focused on buying and owning specific products (De Medeiros and Ribeiro, 2016). Another possibility would be to extend the studies related to "design for sustainable behavior" where products are designed to promote more sustainable behavior (Lockton et al., 2010; Daae and Books, 2015).

At the same time, since factors such as: the existing amount of solid waste, coupled with the lack of knowledge about the impact of reuse for the human health, and the possibility that harmful substances remain in reused materials and products (Mirabella et al., 2014) comprise barriers to ZW implementation, more scientific research on the subject should be developed. Another frequent question in the analyzed articles was how to develop waste reduction practices that are more economically competitive (Bartl, 2014; Scharff, 2014). Also, analyzing the publications of Zaman and Lehmann (2013a) and Zaman (2014b), Zaman (2016) and Zaman and Swapan (2016) where the authors describe and apply a ZW management tool, it is clear that there is room for new studies that seek to replicate those findings.

It was perceived that studies covering the reduction of waste generation have not been much explored compared to the vast use of end-of-the-line practices. In this way, it can be stated that the management of solid wastes is still mostly used to mitigate the negative impacts caused after waste generation. Punctually, the sampled articles unveil that municipalities and industries have difficulties in elaborating and implementing cohesive plans for the holistic management of solid wastes. Thus, it would be relevant to amplify the execution, as well as the dissemination, of academic studies on Design for the Environment (DfE), Industrial Ecology, Advanced Material Recovery Facilities (MRFs) and Closed-loop Recycling.

Finally, considering the specific results of this article, we recommend the application of research using the case study format, since they have the potential to relate the benefits, challenges, and critical success factors indicated in this study, with the reality of a given scenario, indicating whether the presented factors are relevant, and identifying new factors that could be included in the previous list. The practical application of the results of this study is important, especially regarding the critical success factors, since they are directly related to actions that must be executed to ensure that the ZW goals can be reached.

Appendix A. Selected articles for review about ZW

Author /Year	Journal	Objective and Results (synthesis of abstracts)
Alwan et al. (2017)	Journal of Cleaner Production	The UK Government has set out ambitious plans for all new domestic and commercial buildings to be zero carbon rated by 2016 and 2020 respectively. However, there are also other sustainability issues that need to be addressed by the UK construction industry, particularly negative impacts from the generation of waste. Currently, 100 million tonnes of construction waste, including 13 million tonnes of unused materials, is generated each year, with only 20% currently capable of being recycled. The majority of this waste ends up in landfill, contributing to further pollution of the biosphere. This paper presents a case study demonstrating the former approach within the construction industry. Research and consultancy has been undertaken collaboratively between industry, academia and professional practice in the production of 15 individually designed sustainable dwellings in the North East of England. This project has employed Building Information Modelling (BIM) as a new collaborative working platform, aligned to the Modern Method of Construction (MMC). By situating this inquiry within an authentic case study it has highlighted ineffective strategies, policies and leadership, which have prevented full exploitation of the potential of BIM and MMC towards sustainable production.
Arntz (1993)	Catalyses Today	The new driving forces for process innovation in the near future are summarized. These trends were shown in the catalytically important impacts on recent process developments: zero-waste, oxidation reactions, oxidation with hydrogen peroxide, the use of renewable raw materials and in tine-chemical synthesis, especially asymmetric synthesis. In future, zero-waste and new raw materials will dominate industrial research. To improve the catalytic reactions, a better understanding of the reaction through surface science is necessary to tailor the catalysts. New synthetic materials with specific properties as catalyst and/or support may help to meet future demand.
Ball et al. (2009)	Journal of Engeneering Manufecturing	This paper explores the challenges faced when attempting to design a zero carbon manufacturing facility. A broad scope is adopted from legislation to technology and from low waste to consuming waste. A generic material, energy and waste flow model is developed and presented to show the material, energy and waste inputs and outputs for the manufacturing system and the supporting facility and, importantly, how they can potentially interact. Finally the application of the flow model in industrial applications is demonstrated to select appropriate technologies and configure them in an integrated way.

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Appendix A (*continued*)

Author /Year	Journal	Objective and Results (synthesis of abstracts)
Bartl (2014)	Waste Management & Research	Current European waste policy does not mainly aim to treat waste streams but rather place in the foreground of interest the complete supply chain of a product. Waste prevention and re-use do have the highest priority and they take effect before the end-of-life phase of a product or a material is reached. Recycling only takes the third place whereas recovery and disposal represent the least favourable options. Recycling can help to decrease the consumption of primary resources but it does not tackle the causes but only the symptoms. The philosophy of waste prevention and re-use is completely different since they really tackle the causes. It is self-evident that a decrease of waste will also decrease the consumption of resources, energy and money to process the waste. However, even if European legislation is proceeding in the right direction, a clear decrease in waste generation did not occur up to now. Unfortunately, waste generation represents a positive factor of economic growth. Basically, waste generation is a huge business and numerous stakeholders are not interested to reduce waste.
Barrett and Scott, 2012	Global Environmental Change	This paper provides an in-depth analysis of the links between dematerialisation and climate change mitigation. Methods used for material flow analyses (MFA) within the wider context of industrial ecology (which includes a focus on all resource flows in an economy, not purely material tonnage) tend to focus either on detoxification and pollution reduction or dematerialisation and resource productivity.
Beitzen-Heineke et al. (2017)	Journal of Cleaner Production	Increasing consumer awareness of the environmental and social externalities of food supply chains in developed countries instigates the opening of grocery stores that renounce the use of disposable plastic packaging for their entire product range. The opportunities these novel stores offer in moving to an alternative, more sustainable retail system are currently not well understood. Findings suggest that a wider adoption of zero packaging will require influencing consumer behaviour, convincing suppliers to change their packaging practices, and solving the dependency of food logistics on packaging.
Binnemans et al. (2015)	Journal of Cleaner Production	This review discusses the possibilities to recover rare earths from these "secondary resources", which have in common that they contain only low concentrations of rare-earth elements, but are available in very large volumes and could provide significant amounts of rare earths. The success rate is set to increase if the rare-earth recovery from these industrial waste streams is part of a comprehensive, zero-waste, "product-centric" valorisation scheme, in which applications are found for the residual fractions that are obtained after removal of not only the rare earths but also other valuable (base) metals.
Boyle (2000)	Waste Management	The objective of the survey was to gain information about the pollution prevention and waste management issues organisations perceive they are facing as an important input to a review of the current policy and regulatory framework for waste management and pollution prevention in New Zealand. In comparison with UK and Pennsylvania programmes, the New Zealand waste management and pollution prevention programme was found to be vague, lacking in direction and funding and would not succeed in reducing waste production or effectively managing waste. Clear goals and timeframes need to be established, duties and responsibilities of national and local governments and industry clarified and funding needs to be allocated in order to produce an effective waste management framework in New Zealand.
Bratina et al. (2016)	Journal of Environmental Management	The objectives of the article is to present a batch-processing pilot device of sludge or digestate that allows the following: (1) low pressure and low temperature energy effective drying of from 10% to 40% remaining water content, (2) disinfection of pathogen (micro)organisms, (3) heavy metal reduction, (4) production of products of predetermined quality (e.g. containing different quantities of water; it can be used as a fertilizer, or if the percentage of water in the dry sludge is decreased to 10%, then the dried sludge can be used as a fuel with a calorific value similar to coal).

Appendix A (*continued*)

Author /Year	Journal	Objective and Results (synthesis of abstracts)
Bufoni et al. (2016)	Waste Management	The aim of this study is to investigate and describe the barriers system that precludes the feasibility, or limits the performance of the waste management projects through the analysis of which are the declared barriers at the 432 large waste management projects registered as CDM during the period 2004–2014. Results suggest the main barriers classification in five types: sociopolitical, technological, regulatory, financial, and human resources constraints. Results also suggest that beyond the waste management industry, projects have disadvantages added related to the same barriers inherent to others renewable energies initiatives. Future researches are needed to better and comprehensively understand these relationships and ease the development of tools to alleviate or eliminate them.
Burlakovs et al. (2016)	Resources, Conservation and Recycling	Landfill mining (LFM) constitutes an important technological toolset of processes that regain resources and redistribute them with an accompanying reduction of hazardous influence of environmental contamination and other threats for human health hidden in former dump sites and landfills. This review paper is devoted to LFM problems, historical development and driving paradigms of LFM from 'classical hunting for valuables' to 'perspective in ecosystem revitalization'. The main goal is to provide a description of historical experience and link it to more advanced concept of a circular economy. The challenge is to adapt the existing knowledge to make decisions in accordance with both, economic feasibility and ecosystems revitalization aspects.
Carman et al. (2015)	Marine Pollution Bulletin	Plastics are the most common form of debris found along the Argentine coastline. The Río de la Plata estuarine area is a relevant case study to describe a situation where ample policy exists against a backdrop of plastics disposed by populated coastal areas, industries, and vessels; with resultant high impacts of plastic pollution on marine turtles and mammals. Policy and institutions are in place but the impact remains due to ineffective waste management, limited public education and awareness, and weaknesses in enforcement of regulations. We list possible interventions to increase the effectiveness of policy that require integrating efforts among governments, the private sector, non-governmental organizations and the inhabitants of coastal cities to reduce the amount of plastics reaching and protect threatened marine species.
Chang et al. (2008)	Waste Management	Reduction and recycling initiatives such as producer responsibility and pay-as-you-throw are being implemented in Taiwan. This paper presents a study assessing the impact of recently implemented municipal solid waste (MSW) reduction and recycling management strategies on the characteristics of waste feedstock for incineration in Taiwan. Through the periodic sampling of two typical MSW incineration plants, proximate and ultimate analyses were conducted according to standard methods to explore the influence of MSW reduction and recycling management strategies on incineration feed waste characteristics. In summary, management strategies must be conducted in tandem with the global trend to achieve a zero-waste-discharge country. When implementing these strategies and planning for future MSW management systems, it is important to consider the changes that may occur in the composition and characteristics of MSW over time.
Chang et al. (2013)	Waste Management & Research	This work presents the enforcement performance of recent Haulien County, Taiwan municipal solid waste (MSW) recycling management programs. These programs include: Mandatory Refuse Sorting and Recycling, Diverse Bulk Waste Reuse, Pay-as-youDischarge, Total Food Waste Recycling, Restricted Use on Plastic Shopping Bags & Plastic Tableware, Recycling Fund Management, and Ash Reuse. These programs provide incentives to reduce the MSW quantity growth rate. It was found that the recycled material fraction of MSW generated in 2001 was from 6.8%, but was 32.4% in 2010 and will increase stably by 2–5% yearly in the near future. Survey data for the last few years show that only 2.68% (based on total MSW generated) of food waste was collected in 2001.However, food waste was up to 9.7% in 2010 after the Total Food Waste Recycling program was implemented. The reutilization rate of bottom ash was 20% in 2005 and up to 65% in 2010 owing to Ash Reuse Program enforcement. A quantified index, the Total Recycle Index, was proposed to evaluate MSW management program performance. The demonstrated county will move toward a zero waste society in 2015 if the Total Recycle Index approaches 1.00.

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Appendix A (*continued*)

Author /Year	Journal	Objective and Results (synthesis of abstracts)
Cherubini et al. (2008)	Waste Management	In this work we analyse selected alternative scenarios aimed at minimizing the unused material fraction to be delivered to the landfill. The approach was applied to the case of municipal solid waste (MSW) management in Rome, with a special focus on energy and material balance, including global and local scale airborne emissions. Results, provided in the form of indices and indicators of efficiency, effectiveness and environmental impacts, point out landfill activities as the worst waste management strategy at a global scale. On the other hand, the investigated waste treatments with energy and material recovery allow important benefits of greenhouse gas emission reduction (among others) but are still affected by non-negligible local emissions.
Chiang et al. (2014)	Chemical Engineering Journal	A three-stage process was developed to transform blast furnace slag (BFS) into two valuable products: precipitated calcium carbonate (PCC) and zeolitic materials.
Chifari et al. (2016)	Ecological Indicators	We report on the development of a holistic framework to organize and integrate quantitative information characterizing the performance of Urban Waste Management Systems (UWMS) across dimensions and scales. We perceive the UWMS as an organ of a socio-ecological system that modulates the interaction between the metabolic processes of the urban area and those of the embedding ecosystems providing inputs and local sink capacity. The proposed framework can accommodate various indicators referring to the socio-economic performance of the UWMS (viability and desirability) and those related to environmental impact/stress (feasibility). Theoretical considerations are illustrated with preliminary data from a case study on the Metropolitan Area of Naples, Italy.
Clay et al. (2007)	Journal of Cleaner Production	Sustainability Victoria is a State Government agency working with Victorians to use resources more sustainably and to reduce the everyday environmental impacts of communities and business. This paper discusses Victoria's past successes with recycling and cleaner production, the lessons learnt from these programs and how Sustainability Victoria is stimulating behaviour change across the production and consumption cycle through the establishment of innovative partnerships, towards the goal of high factor improvements in resource efficiency.
Cole et al. (2014)	Resources, Conservation and Recycling	Many developed countries are using a challenging Zero Waste concept to change current waste management practices to more sustainable methods of managing waste, including household waste. This paper describes the steps taken by the authors, together with Charnwood Borough Council (CBC), to devise and implement a Zero Waste Strategy (ZWS). A series of focus groups were held involving elected members of the LA and members of the community. The aim was to identify the core aspects of environmental, operational and social demands in order to prioritise actions to be included in a draft ZWS. Key findings from this research are to switch the focus from recycling to reuse and waste prevention, alongside increasing education and behaviour change programmes for householders. Additionally, the potential value of separately collecting food waste, with a recognised high potential yield, must be explored to ensure meeting targets set in the ZWS and the requirements of the Landfill Directive.
Colon and Fawcett (2006)	Habitat International	This paper presents two case studies on the efforts by a community-based organisation to promote a sustainable integrated waste management system in Indian mega cities. The results indicate limited success of the schemes both in saving a significant fraction of the generated waste from dumping, and in rehabilitating the local poor. However, they show that motivated individuals can successfully set up and manage waste collection systems that lead to overall environmental improvements. The differences in the two schemes reflect how the local assets and contexts impact on the success of the scheme. The scheme in a rich neighbourhood of Hyderabad was less ambitious in its overall objectives and focussed on the provision of a waste management service, using the opportunity to provide local employment to a socially deprived fraction of the population. The scheme in a middle-class area of Chennai, although pioneering in its approach, suffered from diseconomies of scale and lack of social integration, making it less viable in the medium to long term. Both schemes suffered from a lack of community involvement, motivation and political support, which threatens the long-term sustainability of the enterprise. The research concludes that the role that communities can realistically play in management of their own waste depends on the local context.

Appendix A (*continued*)

Author /Year	Journal	Objective and Results (synthesis of abstracts)
Corvellec (2016)	Waste Management	This paper presents a qualitative analysis of a sample of fifty-one Swedish waste prevention initiatives with the purpose of identifying which kind of actions are imagined, promoted, and set into motion under the label of waste prevention. The analysis shows that despite their apparent variety, the initiatives in the sample boil down to three main types of actions: raising awareness about the need to prevent waste, increasing material efficiency, and developing sustainable consumption. In contradistinction to the formal definition of waste prevention in the European Waste Framework Directive (2008/98/EC), what emerges from analyzing the initiatives in the sample is a performative definition of waste prevention as something heterogeneous, contradictory, and evolving.
Couth and Trois (2012)	Waste Management	Greenhouse gas (GHG) emissions per person from urban waste management activities are greater in subSaharan African countries than in other developing countries, and are increasing as the population becomes more urbanised. Waste from urban areas across Africa is essentially dumped on the ground and there is little control over the resulting gas emissions. A much more efficient and cost effective way to control GHG emissions from waste is to stabilise the waste via composting and to use the composted material as a soil improver/organic fertiliser or as a component of growing media. Compost can be produced by open windrow or in-vessel composting plants. This paper shows that passively aerated open windrows constitute an appropriate low-cost option for African countries. However, to provide an usable compost material it is recommended that waste is processed through a materials recovery facility (MRF) before being composted. The paper demonstrates that material and biological treatment (MBT) are viable in Africa where they are funded, e.g. CDM.
Curran and Williams (2012)	Journal of Hazardous Materials	'ZeroWIN' (Towards Zero Waste in Industrial Networks – www.zerowin.eu) is a five year project running 2009–2014, funded by the EC under the 7th Framework Programme. Project ZeroWIN envisions industrial networks that have eliminated the wasteful consumption of resources. Zero waste is a unifying concept for a range of measures aimed at eliminating waste and challenging old ways of thinking. Aiming for zero waste will mean viewing waste as a potential resource with value to be realised, rather than as a problem to be dealt with. The ZeroWIN project will investigate and demonstrate how existing approaches and tools can be improved and combined to best effect in an industrial network, and how innovative technologies can contribute to achieving the zero waste vision.
Deus et al. (2016)	Journal of Cleaner Production	This study aims to evaluate the environmental impact of inserting a recycling, composting and integrated program in a region of Sao Paulo State, Brazil through the Waste Reduction Model method simulation of greenhouse gases emission (carbon dioxide equivalent and carbon equivalent) and energy use. The results show that recycling and composting can minimize the emission of greenhouse gases, reducing carbon dioxide and carbon equivalents, and promote energy savings. The best result is the integration of these techniques, which can reduce 78.8% of carbon dioxide and carbon equivalents and save 490.9% in energy versus baseline scenario. This study supports municipalities creating scenarios as a tool for planning and decision making to reach targets proposed by solid waste policies.
Ewijk and Stegemann (2016)	Journal of Cleaner Production	In this paper, the waste hierarchy is analyzed on a conceptual level by studying its original aims, its potential to fulfill those aims, and its actual policy implementation. Issues with the hierarchy include limited specification and implementation of prevention, a lack of guidance for choosing amongst the levels of the hierarchy and the absence of a distinction between open-loop and closed-loop recycling. Also, the hierarchy only communicates relative priorities and therefore does not support decisions that affect other sectors as well as waste management. The article concludes that the waste hierarchy in its current form is an insufficient foundation for waste and resource policy to achieve absolute reductions in material throughput.
Farmer et al. (2015)	Waste Management	This study analysed Local Authority Collected Waste (LACW) for England, at national, regional and sub-regional level, in terms of the destination of household waste to landfill, incineration and recycling. Information about waste partnerships, waste management infrastructure and collection systems was collected to help identify and explain changes in waste destinies. We conclude that there is a need for clearer national strategy and co-ordination to inform and guide policy, practice, planning and investment in infrastructure such that waste management can be better aligned with the principles of the circular economy and resource efficiency. If the ongoing stand-off between national political figures and the waste sector continues, England's waste policy remains destined for indecision.

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Author /Year	Journal	Objective and Results (synthesis of abstracts)
Ferreira et al. (2017)	Waste Management	This paper addresses the assessment and benchmarking of selective collection schemes, relevant to guide future operational improvements. In particular, the assessment is based on the monitoring and statistical analysis of a core-set of performance indicators that highlights collection trends, complemented with a performance index that gathers a weighted linear combination of these indicators. This combined analysis underlines a potential tool to support decision makers involved in the process of selecting the collection scheme with best overall performance. The presented approach was applied to a case study conducted in Oporto Municipality, with data gathered from two distinct selective collection schemes.
Fischer and Pascucci (2016)	Journal of Cleaner Production	The aim of this paper is to gain insight into how requirements for transitioning to circular economy creates new organizational forms in inter-firm collaborations, and ultimately how they stimulate the emergence of new institutions enhancing sustainability. This research compares and contrasts empirical evidence from cases derived from the textile industry in The Netherlands, and concepts derived from institutional analysis and literature on circular economy to inductively build a cohesive conceptual framework. Using information from cases we identified two pathways to transition into circular economy and to manage circular material flows. We define these pathways Status Quo arrangements (SQ), when firms focus on optimizing up-cycling technologies and infrastructure in their circular relations and collaborations, and Product as Service arrangements (PAS), to indicate a focus on providing products in service contracts. Chain coordination, contracting, and financial mechanisms were identified as key organizational elements for creating new pathways to transition into circular materials flows. Moreover PAS arrangements may have bottom up effects at a formal institutional level, resulting in alteration and creation of formal rules, for example in terms of new approaches to the ownership of materials.
Fricker (2003)	Futures	The emphasis on waste reduction is still on the end products, on reuse and recycling. The emphasis on efficiency is too restricted for it has multiple meanings. The benefits are limited.T he emphases are well intentioned but counter-productive while we continue to employ processes and develop products not found in nature. They divert our attention away from developing processes and products which emulate the natural world.
Fudala-Ksiazek et al. (2016)	Waste Management	This project focuses on the leachates from landfill prisms, including modern prism (MP) that meet EU requirements and previous prism (PP) that provide for the storage of permitted biodegradable waste as well as technological wastewaters from sorting unit (SU) and composting unit (CU), which are usually overlooked. The obtained data show that SU and especially CU generate wastewater that is rich in nutrients, organic matter and heavy metals. Through their on-site pre-treatment and recirculation via landfill prisms, the landfill waste decomposition process may be accelerated because of the introduction of organic matter and greenhouse gas emissions may be increased. These results have been confirmed by the progressive abundance of both archaeal community and the methyl coenzyme M reductase (mcrA) gene. The resulting multivariate data set, supported by a principal component analysis, provides useful information for the design, operation and risk assessment of modern MSWPs.
García-Serna et al. (2007)	Chemical Engeneering Journal	Firstly, a review of the concept of sustainability and its significance for the chemical and process industry is presented. Then, several inspiring philosophies and disciplines which are the basis of the new trends in design are briefly reviewed, namely, The Natural Step, Biomimicry, Cradle to Cradle, Getting to Zero Waste, Resilience Engineering, Inherently Safer Design, Ecological Design, Green Chemistry and Self-Assembly. The core of the manuscript is a deep review of what has been done in Green Engineering so far, including its main definitions and scope of application, different guiding principles, frameworks for design and legislative aspects. A range of illustrative industrial applications and several tools oriented to GE are analysed. Finally, some educational considerations andtraining opportunities are included, providing education at academic and university levels allows for the creation of a critical mass of engineers and scientists to foster green engineering and sustainable development in the future.

Appendix A (*continued*)

Author /Year	Journal	Objective and Results (synthesis of abstracts)
Geng et al. (2013)	Journal of Cleaner Production	In this paper an integrated model on green university is proposed. Such a model aims to manage all the campus activities on a sustainable basis. It addresses all the issues related with one university's metabolism and ensures that the views and goals of different stakeholders are considered together. In order to test its feasibility, a case study approach is employed. Shenyang University (SU) was chosen due to its unique feature and data availability. The achievements that Shenyang University has made have demonstrated a robust model to other Chinese universities so that they can start their initiatives by considering their own realities. During this process, the close collaboration with local government, strong leadership and a comprehensive plan will be necessary so that all the stakeholders can join it and more resources can be gained to support its implementation.
Greyson (2007)	Journal of Cleaner Production	This paper suggests how an approach designed to prevent waste and other global impacts could be based upon the established practices of precycling, circular economic policy and recycling insurance. A new economic instrument called 'precycling insurance' is proposed, so that decision-making can be led by the market rather than by prescriptive regulation or educational campaigns. The approach gains relevance now that China is developing a national 'Law on the Promotion of the Development of Circular Economy'.
Gutberlet (2015)	Waste Management	The paper describes the complex operations of recycling cooperatives and draws attention to their economic, environmental, and social contributions. A detailed discussion based on empirical data from the recycling network COOPCENT-ABC in metropolitan São Paulo, Brazil, contextualizes this form of urban mining. The analysis is situated within Social and Solidarity Economy (SSE) and Ecological Economy (EE) theory. Current challenges related to planning, public policy, and the implementation of cooperative recycling are analysed on the level of individual recyclers, cooperatives, municipalities and internationally. There are still many hurdles for the informal, organized recycling sector to become recognized as a key player in efficient material separation and to up-scale these activities for an effective contribution to the SSE and EE. Policies need to be in place to guarantee fair and safe work relations.
Halloran et al. (2014)	Food Policy	Food waste and loss is a major societal, economic, nutritional and environmental challenge. Using the case of Denmark, this paper analyses causes of food waste, and discusses how different stakeholders address the prevention and reuse of the €1.18 billion of annual edible food waste.
Haslenda and Jamaludin (2011)	Resources, Conservation and Recycling	This paper presents a systematic framework for optimal utilization of by-products generated during crude palm oil refining processes. Three by-products are considered in the supply chain network: soapstock, palm fatty acid distillate (PFAD) and spent bleaching earth (SBE). These by-products, generated from neutralization, deodorization and bleaching processes, are viable feedstocks to other commercial industries such as animal feed, biodiesel, lubricant and soap. The case study is formulated as Mixed Integer Linear Programming (MILP) and integrated into the framework with the objective to maximize the refinery's profit as well as moving towards a conscious mindset of zero waste. This is the first time that such framework is developed and applied for the palm oil industry.
Hottle et al. (2015)	Waste Management	This study evaluated seven different waste management strategies for venue-based events and characterized the impacts of event waste management via waste audits and the Waste Reduction Model (WARM). The seven waste management scenarios included traditional waste handling methods (e.g. recycle and landfill) and management of the waste stream via composting, including purchasing where only compostable food service items were used during the events. Waste audits were conducted at four Arizona State University (ASU) baseball games, including a three game series. The findings demonstrate a tradeoff among CO2equivalent emissions, energy use, and landfill diversion rates.

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Author /Year	Journal	Objective and Results (synthesis of abstracts)
Hutner et al. (2017)	Journal of Cleaner Production	The objective of this study is to explore key factors that influence engagement in waste prevention activities, thus helping to clarify why waste prevention, although adopted at both the European and national levels, has so far not been successfully implemented. We investigate the status quo, potentials of and barriers to waste prevention within local authorities in Germany and identify measures for waste prevention. The study is based on a survey simultaneously addressing 386 Bavarian municipalities by questionnaire and on personal interviews with 33 executives and employees of public administration from three different local authorities. Results verify that the implementation status of waste prevention measures among local authorities is generally low. The estimation of waste prevention potentials varies depending on the waste stream. Main barriers are the low acceptance for waste prevention activities and a lack of information. A total of 25% of all interview partners felt that environmental awareness in general is a mandatory condition for behavioral change.
Ilic and Nikolic (2016)	Habitat International	This paper is focused on the drivers that have the biggest impact on waste management in Serbia and improvement of the system by changing the impact of the drivers. The objective is related to waste management drivers in the context of circular economy. This includes establishing baseline data on waste and assessment of the current waste management system, setting future goals, identification of issues, plans for integrated waste management and their implementation. The paper identifies bottlenecks that restrict Serbian's sustainable development, such as low levels of reuse, recycling and recovery of waste, shortage of advanced technology, significant waste disposal amounts and weak economic incentives. The comparison is made with the Municipality of Ljubljana approach to Zero waste practice and circular economy. This analysis depicts real opportunities for more sustainable and efficient waste management in the municipalities and suggests a step forward towards the integrating best Zero Waste practices in the municipalities in developing countries
Islam (2017)	Science of The Total Environment	This study evaluates the GHG emissions and carbon flow of existing and proposed municipal solid waste management in Bangladesh through scenario analysis, including landfill with landfill gas (LFG) recovery, waste to energy (WtE), and material recovery facility (MRF).
Kelly et al. (2006)	Resources, Conservation and Recycling	In order to gain a better understanding of the attitudes and behaviour of a campus community toward a university concourse-based recycling scheme, a survey of 1400 students and staff, at Massey University, New Zealand was conducted. A written questionnaire focused on how recycling participation and source separation performance might be improved, and on general attitudes within the university community toward recycling. The recycling scheme was generally well supported, with predominantly positive recycling attitudes and self-reported recycling behaviour indicated for both students and staff. The major suggested improvement to the concourse system was to have better signage in more appropriate places, and there was strong support for extension of the recycling scheme across the wider campus. Significant relationships were found between self-reported recycling behaviour and attitudes toward recycling, self-reported recycling behaviour and campus occupation (student, postgraduate student, academic staff, or general staff) and self-reported recycling behaviour and place of work.
Kulkarni et al. (2014)	Procedia Social and Behavioral Sciences	The present study, through secondary data, analyzes the different strategies adopted for waste management in the Indian automobile sector. The study reveals that automobile industry in India is gradually moving towards to zero waste generation zone, but has to go long way. The authors conclude that it is not only the legal framework which will help in attaining sustainability but the organization's value and culture will impacts the most in waste management practices.

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Author /Year	Journal	Objective and Results (synthesis of abstracts)
Lehmann (2011)	Sustainability	This paper reports on best practice of urban design principles in regard to materials flow, material recovery, adaptive re-use of entire building elements and components (design for disassembly‘; prefabrication of modular building components), and other relevant strategies to implement zero waste by avoiding waste creation, reducing wasteful consumption and changing behaviour in the design and construction sectors. The paper touches on two important issues in regard to the rapid depletion of the world‘s natural resources: the built environment and the education of architects and designers (both topics of further research). One of the findings of this paper is that embedding zero-waste requires strong industry leadership, new policies and effective education curricula, as well as raising awareness (through research and education) and refocusing research agendas to bring about attitudinal change and the reduction of wasteful consumption.
Leigh and Li (2015)	Journal of Cleaner Production	This study aims to develop a conceptual framework to embrace the integration and identify opportunities for companies to work collaboratively. The initial framework was proposed based on the review of the literature associated with environmentally sustainability supply chain management, Industrial Ecology, and Industrial Symbiosis. The initial framework is improved by corroborating the case study company’s experience, a large UK distributor. Different hierarchies in waste management have also been considered when developing the framework. The paper emphasises the importance of prevention and reduction methods. The developed framework illustrates the areas and opportunities for supply chain parties to work collaboratively towards environmentally friendly activities.
Leo and Salvia (2017)	Renewable and Sustainable Energy Reviews	This paper focuses on the methods developed and the main results achieved in the framework of RE-SEEties “Towards resource-efficient urban communities in SEE”. The main focus is on the eight partner cities and how they were assisted by professional institutions in translating their commitments towards resource efficiency into Local Strategies and Action Plans. A critical comparison of these final results points out differences and similarities in the state-of-the-art of cities across South East Europe as well as a the level of ambition and difficulties faced to turn into resource efficient urban communities.
Li et al. (2015)	Journal of Environmental Management	In this study, the role of green supply chains in eco-industrial parks (EIPs) towards a green economy was investigated. The strategies and effective evaluation procedures of the green economy were proposed by assessing the barriers from the perspective of institution, regulation, technology, and finance. In addition, three case studies from iron and steel-making, paper mill and pulping, and petrochemical industries were presented and illustrated for building the green supply chains. It suggests that the green supply chains should be established to achieve both economic growth and environmental protection. With these successful experiences, building a green supply chain within industrial park should be extensively promoted to make traditional industries around the world being environmentally bearable, economic viable, and social equitable.
Lim et al. (2014)	Renewable and Sustainable Energy Reviews	This study attempts to apply a choice experiment (CE) to four attributes or types of benefits such as the improvement of energy security, reduction of GHG emissions, job creation, and extension of landfill life expectancy. A survey of 500 households was undertaken in Seoul, Korea. The trade-offs between price and the four attributes for selecting a preferred alternative are considered in the CE survey and a marginal willingness to pay (MWTP) estimate for each attribute is derived. The findings can provide policy-makers with useful information for evaluating and planning waste-to-energy policies and projects.
Lu et al. (2006)	Waste Management	This study describes and evaluates the municipal solid waste management system in Taiwan. The study’s results indicate that the amount of MSW began to decline after 1997, when the government enforced aggressive MSW management policies. Summarizing the successful experience of MSW reduction in Taiwan, the most important factor was the government’s combining of the MSW collection system with reduction/recycling programs. The second most important factor was the policy of extended producer responsibility, which laid a foundation of recycling by producers and retailers and promoted public recycling.

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Author /Year	Journal	Objective and Results (synthesis of abstracts)
Lu and Yuan (2013)	Renewable and Sustainable Energy Reviews	Previous studies have reported on waste reduction potential from adopting prefabrication in various economies including Hong Kong. The aim of this study is to empirically investigate the manufacture and cross-border transportation processes, thereby to assess the waste reduction potentials of using prefabrication in construction. It does so by conducting three in-depth case studies with selected PRDR prefabrication factories. A hybrid of research methods are employed in the study. It is found that the waste generation rate in the upstream processes of offshore prefabrication is around 2% or lower by weight. This proves the orthodox that prefabrication in a factory environment is more conducive to waste reduction than the traditional cast in-situ construction manner. However, transporting the components adds cost and simultaneously increases the risk of waste generation. This study provides insights into understanding construction waste reduction through offshore prefabrication from a holistic view.
Mason et al. (2003)	Resources, Conservation and Recycling	A zero waste program was established at a university campus. The implementation procedure consisted of initial discussions with academic and local authority staff at a university environmental forum, the formation of a working group, the preparation of a funding proposal and the establishment of an externally funded research, educational and promotional program led by an academic staff member. Support from senior management existed in the form of a written environmental policy and a signed commitment to environmental responsibility in tertiary education and university funding support followed the success of the initial funding application. In order to enable full program development however, a need for linkages between all sectors involved in the program and the introduction of a formal environmental management system was identified.
Mason et al. (2004)	Resources, Conservation and Recycling	Source separation systems for solid residuals were introduced to the kitchen/cafeteria and concourse areas of a 9000 student university campus. A cross contamination analysis showed that improved source separation performance could increase the recycle rate to 88% (w/w) for the kitchen/cafeteria residuals stream and to 84% (w/w) in the concourse area. Major recyclable materials present in the kitchen/cafeteria "rubbish" stream were food, paper and plastics, whilst food, glass and plastics were the major cross-contaminants in the concourse area. Food streams in both areas were relatively clean. Food residuals were found to be suitable for composting in combination with on-campus green (yard) waste, whilst most other separated streams were either accepted in practice, or technically suitable, for recycling. Improved ongoing education and training is required in order to achieve a high standard of source separation performance from both the kitchen/cafeteria staff and the university community.
Matete and Trois (2008)	Waste Management	The aim of this paper is to describe the optimisation of Waste Minimisation/Zero Waste strategies into an already established integrated waste management system and to present a Zero Waste model for post-consumer waste for urban communities in South Africa. Two communities, adjacent to the Mariannhill Landfill site in Durban, were selected as a case study for a comparative analysis of formal and informal settlements. Since the waste generated from these two communities is disposed of at the Mariannhill landfill, the impact of Zero Waste on landfill volumes could be readily assessed. A Zero Waste scheme, based on costs and landfill airspace savings, was proposed for the area. The case study demonstrates that waste minimisation schemes can be introduced into urban areas, in emerging countries, with differing levels of service and that Zero Waste models are appropriate to urban areas in South Africa.
Matsueda and Nagase (2012)	Resource and Energy Economics	This article provides insights into the economic implications of such a policy through a simple analytical model of a recyclable product and the "Packaging waste Recovery Notes" (PRNs) markets. Our analysis yields two particularly interesting results. First, an increase in the required recycling rate dampens the output and landfill waste levels, while the effect on the level of recycling activities is ambiguous. Second, an increase in the landfill tax always leads to an increase in the landfill waste. We also discuss how the socially optimal landfill tax in the presence of the PRN market should be chosen.

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Author /Year	Journal	Objective and Results (synthesis of abstracts)
McCormick et al. (2013)	Journal of Cleaner Production	This Special Volume of the Journal of Cleaner Production explores sustainable urban transformation focusing on structural transformation processes – multi-dimensional and radical change – that can effectively direct urban development towards ambitious sustainability goals. The 20 articles are based on 35 cases and over 130 surveyed examples of urban initiatives on sustainability in many countries. While cities in Europe dominate, there are also examples from North America, South America, Africa, Asia and Oceania. The combined articles in this Special Volume contribute to knowledge and understanding on sustainable urban transformation across a range of areas, including governance and planning, innovation and competitiveness, lifestyle and consumption, resource management and climate mitigation and adaptation, transport and accessibility, buildings, and the spatial environment and public space.
McGrath (2001)	Resources, Conservation and Recycling	This paper introduces SMARTWaste, a software tool that has been used to audit, reduce and target waste arisings on a construction site. This tool tries to link the construction process and the waste hierarchy. That is reducing waste on a construction site rather than landfilling it. Three applications of the SMARTWaste software will be discussed using case studies from three different types of construction. An evaluation of these case studies shows that, by implementing a waste minimisation scheme on-site, you can improve material recovery for reuse. Also, by using the waste arisings as a benchmark you can reduce your waste arisings on future sites. Application of SMARTWaste or a similar waste minimisation tool on a wider basis could reduce waste arisings and could result in a built environment that consumed less natural resources and energy, and also produced less pollution and waste.
Meeks et al. (2015)	Resources, Conservation and Recycling	This paper identifies and explores where consumers are most likely to come into contact with compostable biopolymers, actual disposal methods, and the motivation behind compostable biopolymer use and disposal. Findings suggest that consumers are most likely coming into contact with compostable biopolymers in a commercial food service setting. The decision to purchase compostable biopolymers was based on a variety of factors, such as their perceived sustainability, but was not directly tied to the ability to compost them. One of the clearest distinctions between those who were able to compost biopolymers and those who sent these products to landfill was the type of sustainability goals each organization set. Yet for all food service categories, disposal decisions relied heavily on the regional waste infrastructure that was available.
Mirabella et al. (2014)	Journal of Cleaner Production	The production of food waste covers all the food life cycle. Increasingly, industrial ecology concepts such as cradle to cradle and circular economy are considered leading principle for eco-innovation, aiming at "zero waste economy" in which waste are used as raw material for new products and applications. The large amount of waste produced by the food industry, in addition to being a great loss of valuable materials, also raises serious management problems, both from the economic and environmental point of view. Many of these residues, however, have the potential to be reused into other production systems, trough e.g. biorefineries. The present work focuses on the use of food waste coming from food manufacturing (FWm). Through extensive literature review, the authors present feasibility and constraints of applying industrial symbiosis in recovering waste from food processing, focusing on recycling (excluding energy recovery) of the solid and liquid waste from food processing industry.
Mohan et al. (2016)	Bioresource Technology	This review illustrates different bioprocess based technological models that will pave sustainable avenues for the development of biobased society. The proposed models hypothesize closed loop approach wherein waste is valorised through a cascade of various biotechnological processes addressing circular economy. Biorefinery offers a sustainable green option to utilize waste and to produce a gamut of marketable bioproducts and bioenergy on par to petro-chemical refinery.

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Author /Year	Journal	Objective and Results (synthesis of abstracts)
Mourad (2016)	Journal of Cleaner Production	Based on more than 120 interviews and complementary observations in the United States and France, this paper examines how recent mobilizations impact the way surplus food is actually managed with respect to sustainable production and consumption. Recent frameworks on food surplus and waste establish one hierarchy of preferable categories of solutions: first, prevention (reducing surplus at the source), then recovery (reusing for human consumption) and finally recycling (feeding animals, creating energy or compost). Drawing on a distinction between "weak" and "strong" sustainability, this paper argues that "strong" prevention based on holistic changes in the food system is the most sustainable solution to food surplus and waste. It suggests that academics focus on strong food surplus prevention, but also that advocates encourage government and corporate actors to differentiate between weak and strong actions to diffuse strong sustainability across organizations and countries.
Murphy and Pincetl (2013)	Resources, Conservation and Recycling	This article asks how effectively and to what extent contemporary urban solid waste management systems can effect sustainable materials use. To assess this first the authors trace the origins of waste management in the U.S., identify the existing federal regulatory framework, and examine trends in waste generation and composition. They then describe waste management in Los Angeles, California, including identifying the city's waste management objectives and current programs, a long-range "zero waste" planning process, and an overhaul of waste collection and processing infrastructure currently underway. They find that, although aggressive, Los Angeles' efforts to achieve zero waste are insufficient for addressing resource conservation challenges. The main reasons for this are continued reliance on waste management approaches that have proven inadequate to address the increasing complexity of solid waste and limited data quantifying and characterizing waste generation patterns.
Obuzor et al. (2012)	Engineering Geology	This paper hence, presents a detailed investigation of the viability of using waste materials, Ground Granulated Blastfurnace Slag (GGBS), gotten from the steel making processes, activated by lime (CaO), in the stabilisation of low bearing capacity clay soils (Lower Oxford Clay). The results achieved, show that road structural layers/embankments constructed on floodplains could be durable with the application of industrial by-product material (GGBS) activated by lime. This has the implication of combining cost effectiveness with improved quality of the materials formulated, thereby enhancing the environmental friendliness of construction processes on flood plains.
Oliveira et al. (2016)	Journal of Cleaner Production	This study examined the alternatives for composting of the organic waste generated in the city of Bauru, in the state of São Paulo, which does not have a composting plant, and analyzed the environmental impacts of seven scenarios. The method consisted of literature review, data collection among the company responsible for the waste management in the municipality, and the Life Cycle Assessment of the scenarios through the software IWM-2 for the Life Cycle Inventory and Recipe2008 conversion factors for the following impact categories: climate change, ozone depletion, particulate matter formation, and human and freshwater toxicity. The results showed that home composting must be followed by a reduction in the organic waste collection days. Also home composting has a greater potential to reduce carbon dioxide equivalent emissions per mass of waste composted in comparison with composting plants.
Pauli (1997)	Journal of Cleaner Production	Industry needs to respond to the needs and the preferences of the market. This implies that industry cannot generate pollution and cause health hazards-no consumer wants that. Zero is the anly feasible target. Industry aims to produce more with the same or less inputs. Ideally, all material, liquid, gaseous and energy inputs should be found in the final product. However, if an industry tries to find this solution within its own processes, it can never succeed in reaching zero. Clusters of industries, where the waste of one is input for the other, will emerge as the solution. The ultimate goal of cleaner production is thus zero waste. This moves industry from pollution prevention and control into the new paradigm that is to become the industry standard.

Appendix A (*continued*)

Author /Year	Journal	Objective and Results (synthesis of abstracts)
Permana et al. (2015)	Habitat International	This study attempts to analyze the current sustainable solid waste management (SSWM) practices in Makassar City, Indonesia. The SSWM practices focused on waste separation and waste recycling. Assessing waste separation and recycling practices were carried out by field observations, focus group discussions, interviews with the actors, and a questionnaire survey. To avoid significant bias in the responses on perceived cleanliness of the city, we classified the respondents into three groups. The primary result of this study shows that the presence of community practices on waste reduction and waste separation was strongly correlated to a sense of cleanliness in the community. This result implicitly indicates that by a using positive environmental image and performance within a locality, the community can become enthusiastically involved and push for sustainable SSWM practices.
Phillips et al. (2011)	Resources, Conservation and Recycling	To help drive the required behaviour change for increased sustainable practice the Government in England signalled up in the Strategy the intention to launch a Zero Waste Places (ZWP) initiative to develop innovative and exemplary practice. By inviting places (including cities, towns and rural communities) to bid for ZWP status, the successful applicants were then expected to become exemplars of good environmental practice on all waste issues. These 6 were chosen from an initial list of 12 applicants via a rigorous selection process against fixed criteria that were designed to support Zero Waste practice. The overall assessment suggests that the Local Authorities and their project partners rose to the challenge of zero waste and in most cases met or even exceeded their objectives and achieved high value for money in terms of Government funded initiatives.
Piippo et al. (2014)	Resources, Conservation and Recycling	Lapland is one of the most attractive nature-tourism areas in Europe, and tourism is vital for local economy. However, recreational tourist activities riding deteriorate the unique and vulnerable nature of Northern Finland. Tourism is also the source of other environmental disturbances such as wastes. Currently, in Lapland, the prevalent waste treatment method is disposal, and wastes are transported over long distances due to lack of recipient facilities for waste management. The suggestion for sustainable waste management Scenario presented in this paper is to find a synergistic solution to both of these problems, by local treatment of bio-waste in an anaerobic digestor and utilization of digestate to revegetate eroded land. It is proposed that bio-waste is co-digested with sewage sludge and offal from slaughterhouses in Ylläs in the municipality of Kolari. Experiences from existing seasonal bio-waste collection schemes and interviews of local tourist enterprises and tourists indicate that there is willingness to extend the source separation of wastes. Assessment of the digestion Scenario suggests that economic costs of investment could be offset by avoided costs and by additional environmental and social benefits.
Pitkänen et al. (2016)	Journal of Cleaner Production	In this study, we explore ten cases of green economy of different sectors and approaches from five European countries and identify factors that have had critical importance for the success or failure of the cases. We identified critical factors related to economic viability, public funding, technological development, impact assessments, public policies and regulation, social capital, leadership and coordination as well as public acceptability and image. According to our results, transition to green economies requires negotiation between potential trade-offs among multiple goals, and interests of various stakeholders. The mutual benefits can be communicated through valid impact assessments and the integration of R&D into the practical implementation.
Priefer et al. (2016)	Resources, Conservation and Recycling	The paper provides information about detailed knowledge on drivers and reasons for food waste generation along the food supply chain and the 'hotspots of wastage'. Main drivers for food waste generation are process- and market-based standards, non-compliance with food safety requirements, exceeding of expiry dates, marketing standards or logistic constraints, but also consumer preferences and societal trends like growing prosperity, declining food prices, rising number of single households and increasing employment of women. As surveys and calculations indicate, the highest waste rates in Europe occur at the first stage (primary production) and the last stage (household sector) of the supply chain. The paper further presents a set of policy options on European and national level which are considered most promising to prevent food waste.

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Appendix A (*continued*)

Author /Year	Journal	Objective and Results (synthesis of abstracts)
Scharff (2014)	Waste Management	This paper analyses more than 20 years of landfill reduction in the Netherlands. The combination of landfill regulations, landfill tax and landfill bans resulted in the desired landfill reduction, but also had negative effects. Regulations have created a financial incentive to pass on the burden of monitoring and controlling the impact of waste to future generations. To prevent this, it is necessary to revise regulations on aftercare and create incentives to actively stabilise landfills.
Seadon (2010)	Journal of Cleaner Production	Waste management is viewed as part of a generation, collection and disposal system. A systems approach that reveals its relationship to other parts of the system is examined in the light of producing more sustainable practice. The move to a more sustainable society requires greater sophistication to manage waste. A traditional reductionist approach is unsustainable as it lacks flexibility and long term thinking. A sustainable waste management system incorporates feedback loops, is focused on processes, embodies adaptability and diverts wastes from disposal. Transitioning to a sustainable waste management system requires identification and application of leverage points which effect change.
Shahbazi et al. (2016)	Journal of Cleaner Production	This study aims to investigate, on a micro-level, further material efficiency improvement opportunities, barriers and strategies in selected manufacturing companies in Sweden. Improvement opportunities at large global manufacturing companies are investigated; barriers hindering material efficiency improvement are identified and categorized at two levels; and strategies that have been deployed at manufacturing companies are reviewed. Empirical findings reveal (1) further potential for improving material efficiency through higher segregation of residual material from mixed and low quality fractions; (2) the most influential barriers are within budgetary, information, management, employee, engineering, and communication clusters; (3) a lack of actual material efficiency strategy implementation in the manufacturing companies.
Shekdar (2009)	Waste Management	High-income countries like Japan and South Korea can afford to spend more to incorporate 3R technologies. Most of the latest efforts focus on “Zero Waste” and/or “Zero Landfilling” which is certainly expensive for weaker economies such as those of India or Indonesia. There is a need to pragmatically assess the expectations of SWM systems in Asian countries. Hence, in this paper, we analyze the situation in different Asian countries, and explore future trends. We conceptually evaluate issues surrounding the sustainability of SWM. We propose a multi-pronged integrated approach for improvement that achieves sustainable SWM in the context of national policy and legal frameworks, institutional arrangement, appropriate technology, operational and financial management, and public awareness and participation. In keeping with this approach, a generic action plan has been proposed that could be tailored to suit a situation in a particular country.
Silva et al. (2017)	Waste Management	Waste policy is increasingly moving on from the ‘prevention of waste’ to a ‘sustainable materials policy’ focused agenda recognising individual wastes as a resource. In order to comparatively analyse policy developments in enhanced waste management, three case studies were selected; San Francisco’s Zero Waste Program, Flanders’s Sustainable Materials Management Initiative and Japan’s Sound Material-Cycle Society Plan. It is suggested that further development in government policy, planning and behaviour change is required. A focus on material policy and incorporating multiple front runners across industry and knowledge institutions are offered as potential directions in the movement away from end-pipe land-fill solutions.
Smol et al. (2016)	Journal of Environmental Management	The aim of this research is to present the possibility of using the sewage sludge ash (SSA) generated in incineration plants as a secondary source of phosphorus (P). Based on available databases and literature, an analysis of the potential use of SSA for P-recovery in Poland was conducted. Currently, approx. 43,000 Mg/year of SSA is produced in large and small incineration plants and according to in the Polish National Waste Management Plan 2014 (NWMP) further steady growth is predicted. This indicates a great potential to recycle phosphorus from SSA and to reintroduce it again into the value chain as a component of fertilisers which can be applied directly on fields. The amount of SSA generated in installations, both large and small, varies and this contributes to the fact that new and different P recovery technology solutions must be developed and put into use in the years to come (e.g. mobile/stationary P recovery installations).

Appendix A (*continued*)

Author /Year	Journal	Objective and Results (synthesis of abstracts)
Snyman and Vorster (2010)	Waste Management & Research	Tshwane is presently landfilling all of its municipal solid waste (MSW) with no pre-processing or minimization efforts. This is a result of the available capacity of its existing landfills, thought to be able to satisfy the city's needs for, at most, the next 10 years. It is possible that the authorities will not wake up to the problem before it is too late. This study addresses these challenges. This study first identified and evaluated technologies available in developed countries for processing the various components of the MSW stream, appropriate to local conditions, as an alternative to landfilling, to ensure that these componentes will be either reused, recycled or rendered harmless to the environment before disposal. Then most appropriate technologies for Tshwane were selected and assembled into an optimal configuration to achieve a zero waste situation in Tshwane within a decade or two. This represents a significant change in MSW management in Tshwane, from total landfill to zero waste to landfill. Although the study focused on Tshwane, it can be argued that the findings can be implemented in any other South African municipality, and even implemented in other emerging countries.
Song et al. (2015)	Journal of Cleaner Production	To prevent further depletion of global resources, sustainable consumption and a strategic waste management system would be required. One approach that has been suggested as a means of addressing these concerns is that of the concepts of "Zero Waste". However, transforming currently over-consuming activities into zero waste is still challenging. In this study, the challenges of solid waste (focusing on industrial waste e-waste, food waste and packaging waste), zero waste practices, and zero waste strategy were discussed to analyze the challenges and opportunities to transform traditional waste management toward zero waste vision. "Zero Waste" is a good solution to minimizing the increasing solid waste. However, in order to minimize the solid waste, there are still more endeavors need to be done in future.
Strazza et al. (2015)	Sustainable Production and Consumption	This paper investigates a potential innovative pattern of recycling food waste from cruise ships for use as feed in aquaculture, in terms of environmental sustainability. Comparative Life Cycle Assessment is used to evaluate the possible potential benefits of replacing conventional formulations of feed mix for salmon with food waste, generated and processed onboard a vessel where turbo-drying technology has been tested as a case study. A set of three indices, otherwise possible stand-alone indicators, is selected to measure global warming potential, non-renewable cumulative energy demand, and water scarcity index. The basis for comparison is represented by a typical commercial feed product for aquaculture in Norway and UK. A conventional feed formulation shows higher life cycle burdens for the whole set of indicators, with respect to the analysed case study. -derived products result to be more influent than fish-derived ones, unlike for carbon and energy indicators.
Timlett and Williams (2011)	Waste Management	Using an analysis of the literature and studies that investigated recycling participation in the city of Portsmouth, the authors have identified three significant clusters that can facilitate effective recycling: infrastructure, service and behaviour (ISB). We present the ISB model – a tool that can be used by waste practitioners when planning interventions to maximise recycling to better understand the situation and context for behaviour. Analysis using the ISB model suggests that current best practice, "business as usual" interventions could realistically achieve a national recycling rate of 50%. If the UK is to move towards zero waste, policy makers must look "upstream" for interventions that change the situational landscape.
Torielli et al. (2010)	China Foundry	The foundry industry, as well as manufacturing in general, has significant challenges in the current regulatory and political climate with developing an economically and environmentally sustainable business model. Lean manufacturing has proven itself as a model for both economic sustainability and environmental stewardship. Several recent studies have shown that both lean and green techniques and "zero-waste" policies also lead to reductions in overall cost. While these strategies have been examined for general manufacturing, they have not been investigated in detail for the foundry industry. This paper will review the current literature and describe how lean and green can provide a relevant framework for environmentally and economically sustainable foundries.

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Author /Year	Journal	Objective and Results (synthesis of abstracts)
Tsai (2008)	Bioresource Technology	The objective of this paper is to present and discuss some management considerations in turning food garbage into agricultural resources due to the compulsory garbage sorting directive in Taiwan. The description first aims at the current status in food garbage generation and its recycling, and at the regulatory polices which have become effective since 2000. It also centers on the environmental and agricultural measures on upgrading food garbage recycling.
Tsai et al. (2007)	Resources Policy	The objective of this paper is to present an integrated evaluation of Municipal Solid Wste (MSW) in light of Taiwan's government laws and regulations. The description first focuses on the current status of MSW generation and clearance and its recycling. It also centers on new, revised legislation and regulations (especially policies concerning environmental protection and financial incentives for MSW recycling), which have become effective since 1997. The regulatory system (i.e., Waste Disposal Act, Environmental Basis Law, and Statute for Upgrading Industries) is not only to give financial incentives, but also to provide technical assistances and transfer of information for promoting resource recycling. As a newly developed country, Taiwan's recycling system—the "4-in-1 Recycling System", which includes the Resource Recycling Management Fund—has successfully proceeded and will provide a costeffective demonstration for those countries that are developing their resource recycling from MSW.
Uyarra and Gee (2013)	Journal of Cleaner Production	This paper deals with a transformation towards a more sustainable waste management system in an urban setting. More specifically, the paper describes how Greater Manchester (UK) underwent a transformation from a relatively simple landfill model to a highly complex, multi-technology waste solution based on intensive recycling and composting, and sustainable energy usage. Against the national trend of incineration with energy recovery, Greater Manchester opted instead for a solution that was deemed more innovative and sustainable, but which involved overcoming significant technological, political and financial challenges. The paper investigates the process that led to this purposive transformation, characterized by a mix of political vision, stakeholder engagement, economies of scale, and the ability of waste disposal managers to gather expertise, resources, political influence and commitment at multiple levels of governance.
Xanthos and Walker (2017)	Marine Pollution Bulletin	This paper reviews current international market-based strategies and policies to reduce plastic bags and microbeads. While policies to reduce microbeads began in 2014, interventions for plastic bags began much earlier in 1991. However, few studies have documented or measured the effectiveness of these reduction strategies. Recommendations to further reduce single-use plastic marine pollution include: (i) research to evaluate effectiveness of bans and levies to ensure policies are having positive impacts on marine environments; and (ii) education and outreach to reduce consumption of plastic bags and microbeads at source.
Warshawsky (2015)	Cities	This paper critically analyzes a local food rescue civil society organization (CSO) as a case study in order to understand the challenges associated with food waste governance in LA and the roles that CSOs play in food waste reduction. Findings illustrate that although local CSOs have expanded their food waste reduction programs, the impact of their operations may be limited. In addition, while CSOs rescue some food, they operate in conjunction with food waste surpluses and the overabundance of food, and do little to reduce the root cause of food waste or food insecurity. Although the structural causes of food waste are arguably beyond the scope of some CSOs to change, data in this paper suggest that some CSOs may contribute indirectly to neoliberal governance when they romanticize the power of local communities, depoliticize food issues, and focus on individual personal responsibility. For these reasons, this research suggests that food waste may only be reduced significantly with more government regulation of the institutions which produce food waste, namely food businesses and households.
Wilson et al. (2015)	Waste Management	The paper presents an indicator set for integrated sustainable waste management (ISWM) in cities both North and South, to allow benchmarking of a city's performance, comparing cities and monitoring developments over time. It builds on pioneering work for UN-Habitat's solid waste management in the World's cities.

Appendix A (*continued*)

Author /Year	Journal	Objective and Results (synthesis of abstracts)
Yang et al. (2017)	Waste Management	The main objective of this work was to promote zero waste of municipal incinerator fly ash (MIFA) by full-scale melting in electric arc furnaces (EAFs) of steel mini mills around the world. It was found that this practice yielded many advantages such as (1) about 18 wt% of quicklime requirement in EAF steelmaking can be substituted by the lime materials contained in MIFA; (2) MIFA would totally end up as a material in fractions of recyclable EAF dust, oxidized slag and reduced slag; (3) no waste is needed for landfilling; and (4) a capital cost saving through the employment of existing EAFs in steel mini mills instead of building new melting plants for the treatment of MIFA.
Yazan et al. (2016)	Journal of Cleaner Production	The aim of this paper is to provide guidelines for the future evolution of Industrial Area (IA) operating on the basis of Industrial Symbiosis (IS) principles. Adopting an enterprise input–output approach, the conditions for a perfect IS are found for one-waste and multi-waste cases, and the distance between the states of the actual network and of the related perfect IS is measured. Proposed approach is empirically applied to Santa Croce sull'Arno industrial district of tannery where the recycling of chrome liquors, fleshing, and wastewater are investigated. Results show under which conditions perfect symbiosis is achievable for two waste types. Policy implications are also suggested for the design of IA when IS principles are adopted.
Yeung (2001)	Ocean & Coastal Management	Coastal mega-cities in Asia have expanded rapidly and are heavily stressed from environmental perspectives. They have undergone momentous physical and socioeconomic transformations, posing severe problems in the utilization and misuse of resources in their immediate area and their hinterlands. Present patterns of coastal development and utilization are not sustainable. It calls for a comprehensive and informed framework to manage Asia's coastal regions, with education and a heightened awareness being the first steps to improvement.
Yoshida et al. (2012)	Resources, Conservation and Recycling	Aiming for the long-term goal of zero waste, the City of Madison has been looking into an opportunity to divert its organic waste from its landfill. Previous studies suggested that organic waste diversion could result in a GHG emission reduction: Alternative treatment of organic waste would reduce GHG emissions through avoidance of landfill methane emission, nutrient replacement, and energy recovery when anaerobic digestion technologies are employed. However, organic waste diversion requires modification of collection practices and additions to the collection fleet. In contrast with the current practice, four alternatives were assessed in this study: windrow composting, high-solids anaerobic digestion, co-digestion at a large scale industrial waste anaerobic digester facility, and co-digestion at the local wastewater treatment plant. The results show that the co-digestion of source-separated organic waste would achieve the highest GHG emission reduction among the alternatives considered.
Zaman (2014a)	Ecological Indicators	This study is aimed to identify the core zero waste indicators which could be used to assess the performance of the zero waste management systems. A set of indicators have been identified by waste experts as the key indicators for the zero waste management systems. After an intensive literature review, the zero waste indicators were broadly categorised in seven different domains such as geo-administrative, socio-cultural, management, economic, environmental, organisational and policy. A total of 238 indicators were identified as preliminary zero waste indicators, and a survey was done with highly experienced waste professionals around the globe for their feedback. Final results showed 56 indicators as the most important indicators for zero waste management systems and were rated as nearly very high priority indicators by the waste experts.
Zaman (2014b)	Journal of Cleaner Production	In the current study, waste management performance in Adelaide during the years 2003–2010 is analysed using the proposed Zero Waste Index tool and thereby Adelaide's performance in waste management in 2015 and 2020 is predicted. The study indicates that waste composting is increasing significantly in Adelaide and by 2015 the amount of waste composted should be higher than that going to landfill. For this reason, the biological waste treatment infrastructure, particularly in waste composting facilities, should be stimulated in Adelaide. In addition, the study identifies that despite the zero waste strategy being in place, overall waste management performance in Adelaide may not reach the targeted zero waste goals, particularly in optimum resource recovery from waste. The projected results indicate that by 2020, if similar waste diversion rates continue, Adelaide should have reached a diversion rate of over 82% of municipal solid waste from landfill and the Zero Waste Index would then be 0.45 (around 45% material substitution from its current ZWI = 0.41 with a 72% diversion rate).

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Author /Year	Journal	Objective and Results (synthesis of abstracts)
Zaman (2015)	Journal of Cleaner Production	This study aims to conceptualize zero waste development based on a critical review of available academic journal publications. This study reveals that the scope of the zero waste studies is diverse, and a zero waste concept is constantly developing through various programmes, plans, policies and strategies. The findings of this review study suggest that the zero waste programmes are applied in many countries without any holistic zero waste strategy. Based on the review findings the study concludes that zero waste concept has been applied widely in different phases of production and waste management systems. The findings of the study assist to identify priority areas of zero waste strategy and to develop national zero waste guidelines. Thus, this study can be useful to policy and decision makers in developing the evidence-based zero waste guidelines.
Zaman (2016)	Journal of Cleaner Production	This study analyses the municipal solid waste management system of 172 countries from all over the globe with a population of 3.37 billion. The findings of this study show that globally, about 84% of the waste is collected and only 15% of the waste is recycled and most of the global waste was still managed by landfills. This study tries to measure the environmental benefits of global waste management systems by applying a tool called the Zero Waste Index (ZWI). The ZWI measures the waste management performance by accounting for the potential amount of virgin material that can be offset by recovering resources from waste. In addition, the ZWI tool also considers the energy, greenhouse gas (GHG) and water savings by offsetting virgin materials and recovering energy from waste. The ZWI of the world in this study is measured to be 0.12, which means that the current waste management system potentially offsets only 12% of the total virgin material substitution potential from waste.
Zaman and Lehmann (2011)	City, Culture and Society	This study aims to understand the key drivers of waste management and the challenges, threats, and opportunities in transforming traditional waste streams and optimizing practices toward zero waste practices. Part of this study is an in-depth case analysis of waste management systems in two cities, Adelaide and Stockholm. Cities from high consuming countries, such as Australia and Sweden, have been analyzed based on five waste management contexts: social, economic, political, technological, and environmental. In addition, key drivers are identified. Both Adelaide and Stockholm have the vision to become "zero waste cities". The study concludes that strategies based on tools, systems, and technologies can assist cities in their transformation into "zero waste cities"; however, they must also be affordable, practicable, and effective within their local regulatory framework.
Zaman and Lehmann (2013a)	Journal of Cleaner Production	This paper conceptualises the concept of the 'zero waste city' and proposes a new tool to measure the performance of waste management systems called the 'zero waste index'. The zero waste index forecasts the amount of virgin materials, energy, water and greenhouse gas emissions substituted by the resources that are recovered from waste streams. Three high consuming cities (Adelaide, San Francisco and Stockholm) were analysed using the zero waste index. The zero waste indexes in Adelaide, San Francisco and Stockholm were found to be 0.23, 0.51 and 0.17 respectively (i.e. around 23%, 51% and 17% of resources were recovered and potentially substituted for virgin materials).
Zaman and Lehmann (2013b)	Waste Management & Research	This study defies the traditional concepts of waste, in which waste was considered as the last phase of production and services, by putting forward the new concept of waste as an intermediate phase of production and services. The study aims to develop a demand forecasting tool called 'zero waste index' (ZWI) for measuring the natural resources recouped from municipal solid waste. The ZWI (ZWI demand forecasting tool) quantifies the amount of virgin materials recovered from solid waste and subsequently reduces extraction of natural resources. In addition, the tool estimates the potential amount of energy, water and emissions avoided or saved by the improved waste management system. The ZWI is tested in a case study of waste management systems in two developed cities: Adelaide (Australia) and Stockholm (Sweden).

Appendix A (*continued*)

Author /Year	Journal	Objective and Results (synthesis of abstracts)
Zaman and Swapan (2016)	Resources, Conservation and Recycling	This paper presents the environmental and economic benefits of global waste management systems in the context of zero waste practices. The study analysed the waste management performance of 168 countries around the globe and evaluated their performance using the zero waste tool. The findings of the study suggested that globally, an average person generated around 435 kg of waste each year, out of which an estimated 50 kg of materials (paper, plastic, metal, glass and others) potentially substitute the demand for the extraction of virgin materials. By substituting the demand for virgin materials, through 'zero waste activities', an average person could potentially save around 216 kWh of energy, 0.05 kg GHG and 36 L of processed water. Globally, each person would then potentially save around $61.3 annually, of which $17 would arise from materials substitution, and $44 from energy substitution.
Zen et al. (2016)	Journal of Cleaner Production	As part of the sustainability initiative in Universiti Teknologi Malaysia, the establishment of a Green Office reveals the complexity of institutionalizing waste minimization in campuses as well as demonstrate the potential of living laboratory framework as an integrative, transformative and structural approach of the triangulation elements of Higher Education Institutions; teaching & learning, research and operation. The first part of the study begins with the science approach in develop waste profile with its' strategic implication; The second part of the study, which is more on the social science approach, analyze through the participatory based approach, governance and institutionalization process of waste minimization.
Zeng et al. (2016)	Journal of Cleaner Production	Based on institutional theory, the authors construct a concept model according to the paradigm of "institution-conduct-performance." After then test the mechanism and relationships among institutional pressure, supply chain relationship management, sustainable supply chain design, and circular economy capability using data collected from eco-industrial park firms in China via 363 questionnaires. The findings show that institutional pressure has a significant positive impact on supply chain relationship management and sustainable supply chain design; sustainable supply chain management practice is an important factor promoting the improvement of the circular economy capability of companies, and coercive pressure, normative pressure, and mimetic pressure exert different degrees of negative moderating effects.
Zhang et al. (2011)	Waste Management	This paper critically reviews why sustainable waste management has become a key issue for the worldwide Higher Education sector to address and describes some of the benefits, barriers, practical and logistical problems. As a practical illustration of some of the issues and problems, the four-phase waste management strategy developed over 15 years by one of the largest universities in Southern England – the University of Southampton (UoS) – is outlined as a case study. As a result of the strategy developed at the UoS, from 2004 to 2008 waste costs fell by around £125k and a recycling rate of 72% was achieved. The holistic approach taken – recognizing the PESTLE factors and the importance of a concerted ISB approach – provides a realistic, successful and practical example for other institutions wishing to effectively and sustainably manage their waste.
Zotos et al. (2009)	Waste Management	The present position paper addresses contemporary waste management options, weaknesses and opportunities faced by Hellenic local authorities. It focuses on state-of-the-art, tested as well as innovative, environmental management tools on a municipal scale and identifies a range of different collaboration schemes between local authorities and related service providers. This paper develops a systemic approach for MSWM at both the household and the non-household level, summarizes state-of-the-art available tools and compiles a set of guidelines for developing waste management master plans at the municipal level. It aims to provide a framework in the MSWM field for municipalities in Greece as well as other countries facing similar problems under often comparable socioeconomic settings.

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