IOP Conference Series: Earth and Environmental Science

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4th International Conference on Eco Engineering Development 2020 10-11 November 2020, Banten, Indonesia

Accepted papers received: 08 June 2021

Published online: 02 August 2021

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Sustainable Industry and Green Manufacturing

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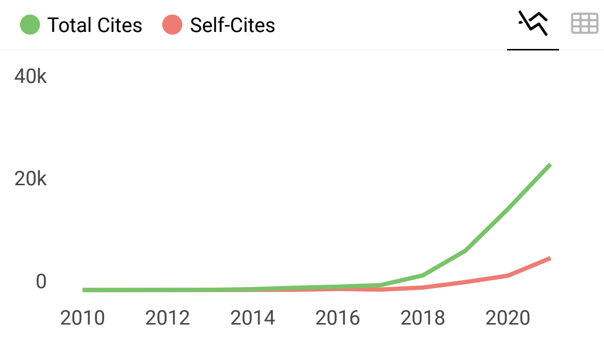

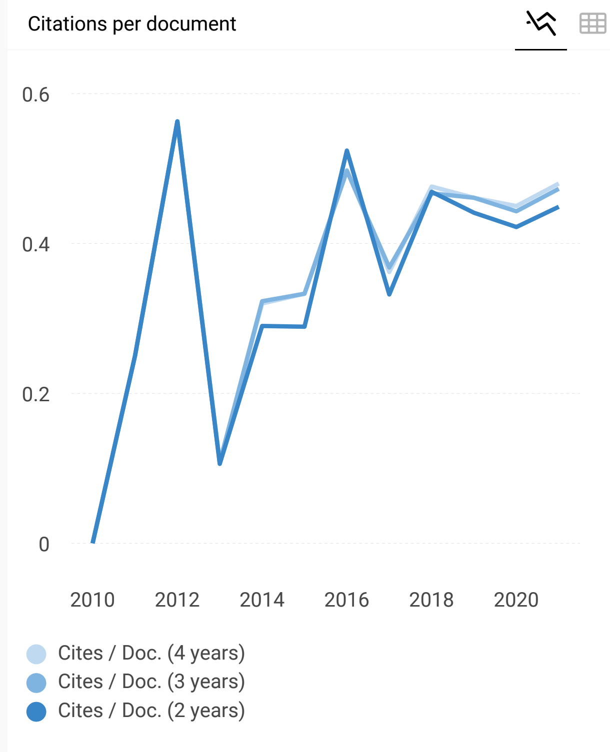

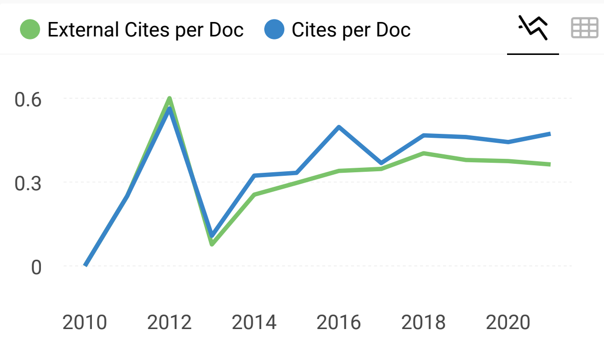

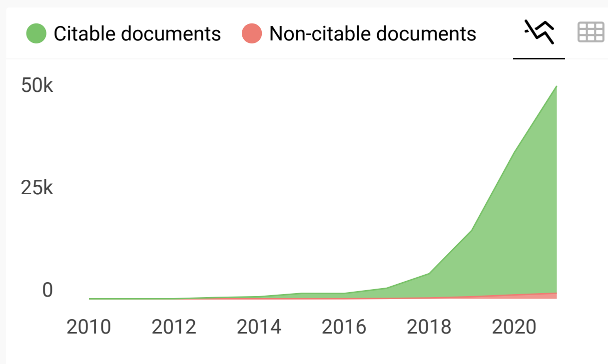

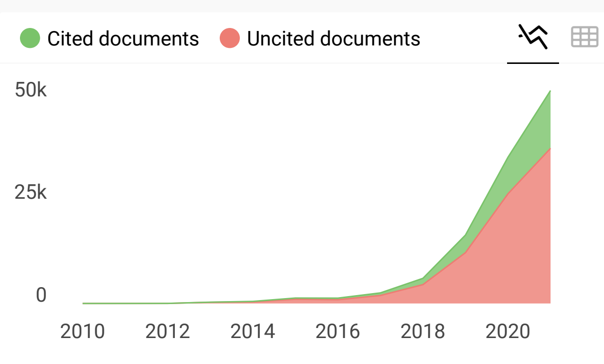

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Melanie Ortiz 3 weeks ago

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N

NAJI 7 months ago

Hello Dear

I participated as a corresponding author in IOP conf .series: Earth and Environment Science 877(2021)012046

I want do this IOP still in Scopus ???

kind regards

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Dear Naji, thank you very much for your comment. We suggest you consult the Scopus database directly. Keep in mind that the SJR is a static image (the update is made one time per year) of a database (Scopus) which is changing every day.
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A

Alharia Dinata 2 years ago

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reply

SCImago Team

Melanie Ortiz 2 years ago

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V

Vani 2 years ago

good evening, whether this journal is Q4 or Q2 ?

reply

SCImago Team

Melanie Ortiz 2 years ago

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Best regards, SCImago Team

F

FEROSKHAN M 2 years ago

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SCImago Team

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M

Mora 3 years ago

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D

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Thank you,

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A

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Melanie Ortiz 3 years ago

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M

Mahipal 3 years ago

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Melanie Ortiz 3 years ago

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If you would like to make an application to Scopus, please contact them to help you with this issue here: https://www.elsevier.com/solutions/scopus/content/content-policy-and-selection
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M

Mursalin 3 years ago

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Please help me to resolve the issue. Thank you for your kindness. I am waiting for good news from you.

Sincerelly,
Mursalin

reply

SCImago Team

Melanie Ortiz 3 years ago

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N

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reply

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Melanie Ortiz 3 years ago

Dear user, thank you very much for your request. You can consult that information in SJR website. Best Regards, SCImago Team

S

syaiful 4 years ago

I am very interested to send my paper to this conference best regards

syaiful

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SCImago Team

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Conceptual framework for the development of West Java Zero Waste Management Index

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Conceptual framework for the development of West Java Zero Waste Management Index

E J Sundana[1], A D Sutadian[1] and I Juwana[2]

[1]Research and Development Agency of West Java Province (BP2D Jawa Barat), Bandung, Indonesia
[2]Department of Environmental Engineering, Institut Teknologi Nasional (ITENAS), Bandung, Indonesia

Corresponding author: eka.sundana@jabarprov.go.id

Abstract. Over the past decade, zero waste emerged as one of the promising concepts for waste management. Many parties have introduced this concept as a new way of waste management, aiming to reduce as little amount of waste generated as possible and send nothing to landfills. To measure the success of the zero waste implementation, some set of indicators have been developed. Although these were claimed to be successful after their implementation, very often they are not applicable to other regions or countries. Therefore, this study recommends developing the Zero Waste Management Index, which fits with local or regional conditions. This paper will discuss a framework for developing the West Java Zero Waste Management Index (WJZWMI). It will outline urban solid waste problem in West Java, and a brief review of existing zero waste indexes. Further, it will emphasize on the conceptual framework of the WJZWMI, which then results in potential long list indicators as preliminary results of this study, while also charting pathways for future works in developing a comprehensive zero waste management index for West Java Province.

Keyword: framework, development, zero waste, management index

1. Introduction

Urban solid waste has emerged as a serious global problem. Managing it requires not only technical measures, but also complex and multi-disciplinary approaches. Without proper management, global solid waste generation will increase by 70% from 2.1 million tonnes in 2016 to 3.4 million tonnes in 2050 [1]. In developing countries - where urbanization rate and population growth are high, while financing capacity is limited – solid waste management services often failed to be delivered reliably and efficiently [2]. West Java, as the most populated and urbanized province in Indonesia, is also facing this serious problem, as waste generation is increasing but the availability of land to be used as final disposal site is extremely limited [3]. Therefore, solid waste management effort that is heavily focused on 'collect-transport-disposal' (or known as 'end-of-pipe' approach) must be shifted to an approach that aims to reduce waste generation from the source (or known as 'up-the-pipe' approach), in order to reduce the burden of overall solid waste management cost [4].

Zero waste concept is an emerging and a promising solid waste management approach for urban areas. In the past few years, many cities have introduced the concept as a new way or paradigm in managing solid waste as an effort to reduce waste generation from the source, and in turn, reduce the volume of waste being sent to final disposal site (landfill). In fact, the goal of zero waste concept is to

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"send nothing to the landfill" [5]. Zaman dan Lehmann [6] further defined zero waste as a comprehensive solid waste management concept which treats waste as a form of inefficiencies from the activities of modern society. They further elaborate that zero waste concept transforms the conventional definition of waste as something useless to useful resources in a sustainable consumption cycle. In Indonesia, zero waste concept has been adopted by The Solid Waste Management Law No. 18/2008, and then further elaborated by the Presidential Decree No. 97 Year 2017 concerning The National Policy and Strategies for Municipal Solid Waste Management, which focused on two main approaches: (1) waste reduction and (2) waste handling. The Decree has defined a national target of 30% waste reduction to be achieved in 2025. However, in order to be properly implemented by local governments, it is urgent to develop appropriate performance indicators that can be measured simply, interpreted easily, while also accessible and reliable for monitoring waste reduction [7]. Further, the combination of complex solid waste management indicators can be represented by an index, which is an aggregate measure that can be useful in describing the problems in a simplified manner and thus help in focusing on key issues [8]. An assessment of a host of aspects is allowed by such approach, which can then be translated into a single comparable index [9].

This paper will discuss a framework for developing the West Java Zero Waste Management Index (WJZWMI). It will outline urban solid waste problem in West Java and conduct a brief review of existing zero waste indexes. Further, it will emphasize on the conceptual framework of the WJZWMI, which then results in potential long list indicators as preliminary results of this study, while also charting pathways for future works in developing a comprehensive zero waste management index for West Java Province.

2. Solid Waste Problem in West Java Province

West Java, with almost 50 million inhabitants, is the largest populated province in Indonesia. With the ever increasing population growth, solid waste management problem becomes an increasingly crucial issue. Based on the latest report, West Java generates almost 27.5 tonnes of municipal solid waste per day [3]. The report also explained that current practices of solid waste management still focus on waste collection, transportation, and dump system, which relies heavily on the availability of land for final disposal sites (known as tempatpembuanganakhirsampah or TPAS). Herein lies the problem, as based on the latest study in determining the suitability of land in West Java, most areas are deemed to be not suitable to be used as TPAS. The study, carried out by analyzing the physical parameters that refer to the Standard Procedure for The Selection of Final Waste Disposal Site (SK SNI 17-11-1991-03), is presented into a map as illustrated below.

Figure 1. Land suitability for final waste disposal site in West Java [3]

With the increasing waste generation, with limited level of service, and also with the increasingly limited availability of suitable land to be used as landfills, it is clear that different approach is needed in ensuring the sustainability of waste management in West Java, which not only focuses on final disposal, but also on substantial efforts to reduce waste at its source. To address this issue, the Government of West Java has issued Provincial Regulation No. 1 Year 2016 and then further detailed into waste management policy and strategies (JAKSTRADA) document published in 2018. However, an objective and reliable performance evaluation tool, such as zero waste management index, is urgently needed especially in West Java's effort to reduce the volume of waste being dumped into landfills [3].

3. Existing Zero Waste Index

From global academic journal articles published between 2010 and 2019, there are three indexes that had been developed based on zero waste concept. Unlike other environmental indexes, these Zero Waste indexes do not share common structure and do not involve the opinions of local stakeholders. Even so, the components or indicators used tend to differ greatly from one another, depending on which aspect to focus on. For example, the Zero Waste Index [6] focuses on the efficiency of replacing virgin material from a type of waste that can be avoided, reduced or reused. Meanwhile, the Waste Diversion Rate focuses on the end point of the waste journey by only quantifying the amount of waste sent to the landfill and the amount of waste recycled globally.

Table 1 shows the three indexes that have been developed related to the concept of Zero Waste, its advantages and disadvantages, and the opportunities for its application in West Java Province. Of the three indexes studied, the Waste Diversion Rate is the most commonly adopted index globally in measuring the performance of Zero Waste-based waste management. However, the indicators used in the Waste Diversion Rate do not inform how efficiently virgin material can be saved in a solid waste management system. This lack of information was attempted to be rectified through the development of the Zero Waste Index [6] [10] [11], which mostly focus on environmental conservation. Likewise with the Zero Waste Hierarchy Index, there is no indicator in the index that represents the economic, environmental, financial, or regulatory side of the existing management system. For example, there is no single index that has adopted the targets/goals defined in the Sustainable Development Goals (SDGs), which have become a global guide for all countries in the world in order to apply the principles of holistic sustainable development. A study from Rodić and Wilson [12] has concluded that solid waste management is an overlapping issue that connects 12 out of 17 SDGs. Therefore, a series of indicators is needed that can reflect the condition of managing zero waste as a whole. Furthermore, in the context of data quality and availability, it is difficult for these three indexes to be applied in West Java because the data needed so far are not readily available.

Table1. Existing indexes related to zero waste

1. WASTE DIVERSION RATE

$$Diversion\,rate = \frac{Weight\ of\ recylables}{Weight\ of\ garbage + Weight\ of\ recylables} x100\%$$

Weightofrecyclables: amount of waste to be recycled
Weightofgarbage: amount of waste disposed to landfill or incinerator

Objective	Reference(s)	Advantage	Disadvantage	Opportunity for application in WJ
Represents the amount of waste that is successfully managed through recycling and not disposed of in the landfill	Not available, but this tool has been applied in many countries	• Applied globally; • Simple and easy to be applied.	• Only informing the amount of waste being managed in landfill; • Other indicators related with economic, legal, environmental, etc. are not covered.	• Difficult to be applied as data on recycled waste are not yet recorded properly

2. ZERO WASTE INDEX

$$Zero\ waste\ index = \frac{\sum potential\ amount\ of\ waste\ managed\ by\ the\ city + substituion\ for\ the\ system}{Total\ amount\ of\ waste\ generated\ in\ the\ city}$$

Potentialamountofwastemanagedbythecity: Amount of waste being managed by a city
Substitutionforthesystem: virgin material successfully reused
Total amountofwastegenerated in thecity: Amount of waste generated by a city

Objective	Reference(s)	Advantage	Disadvantage	Opportunity for application in WJ
To measure the sustainability of solid waste management system from environmental perspective.	[6][10][11]	• Already applied in Adelaide (Australia), Stockholm (Sweden) and San Fransisco (USA); • It considers conservation efforts through reused virgin materials, energy and water use, and greenhouse gas (GHGs) emission.	• Relies heavily on the quality of available data; • Other indicators related with economic, legal, institutional, etc. are not covered; • Focusing only on technical aspect; • Does not involve local stakeholders in the development of the index.	• Difficult to be applied in West Java, as the data from every stage of solid waste operation which has circular economy potential are not readily available; • Difficult to be used for program prioritization.

3. WASTE HIERARCHY INDEKS

$$WHI = \frac{\left[(1((PR + UpR + RR + CAD) + aDR + bBT + cWtE)) + (-1\left((1-a)DR + (1-b)BT + (1-c)WtE + I + L\right))\right]}{Total\ waste\ treated}$$

PR: Preparingforreuse
UpR: Upcycling
RR: Re-recyling
CAD: Compostingandanaerobicdigestion
DR: Down-cycling
BT: Biologicaltreatment
WtE: Wastetoenergy
I: Incenerationwithoutenergyrecovery
L: Landfill
a, b, c: level of contribution (0 – 1)

Objective	Reference(s)	Advantage	Disadvantage	Opportunity for application in WJ
Represents various stages of solid waste management operation based on circular economy	[13]	• Provides a comprehensive tool to evaluate technical aspect of solid waste management; • Accurate calculation as it considers the whole process of solid waste management operation based on circular economy.	• Complex and requires technical data from every type of waste process handling; • Not yet adapted as a formal management tool; • Other indicators related with economic, legal, institutional, etc. are not covered; • Focusing only on technical aspect.	• Difficult to be applied in West Java, as the data from every stage of solid waste operation which has circular economy potential are not readily available; • Difficult to be used for program prioritization.

Therefore, a Zero Waste Management Index which is specifically developed through the involvement of local level stakeholders and based on the natural conditions and socio-economic characteristics of West Java Province, is very much needed to improve the governance of waste management in West Java. The index will not only help obtain information on the current conditions of West Java solid waste management in implementing the zero waste concept, but can also become a tool to prioritize existing solid waste issues. The next part will present the proposed conceptual framework for WJZWMI.

4. Proposed conceptual framework

The conceptual framework proposed describes the relationship between the theory underlying and methods/approaches applied in this study, as presented in Figure 2. Steps in the development of an index generally consist of theoretical framework, indicator selection, normalization, weighting and aggregation, and interpretation. In addition, robustness analysis is done to investigate uncertainty attached in an index. To start with, a sound theoretical framework is the starting point in developing a composite index [14]. This research's goal focuses on reliable performance measurements for the implementation of zero waste management in West Java. As for this, the definition of zero waste, used in this study, refers to the Zero Waste International Alliance's [5]:*"The conservation of all resources by means of responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no discharges to land, water, or air that threaten the environment or human health".*

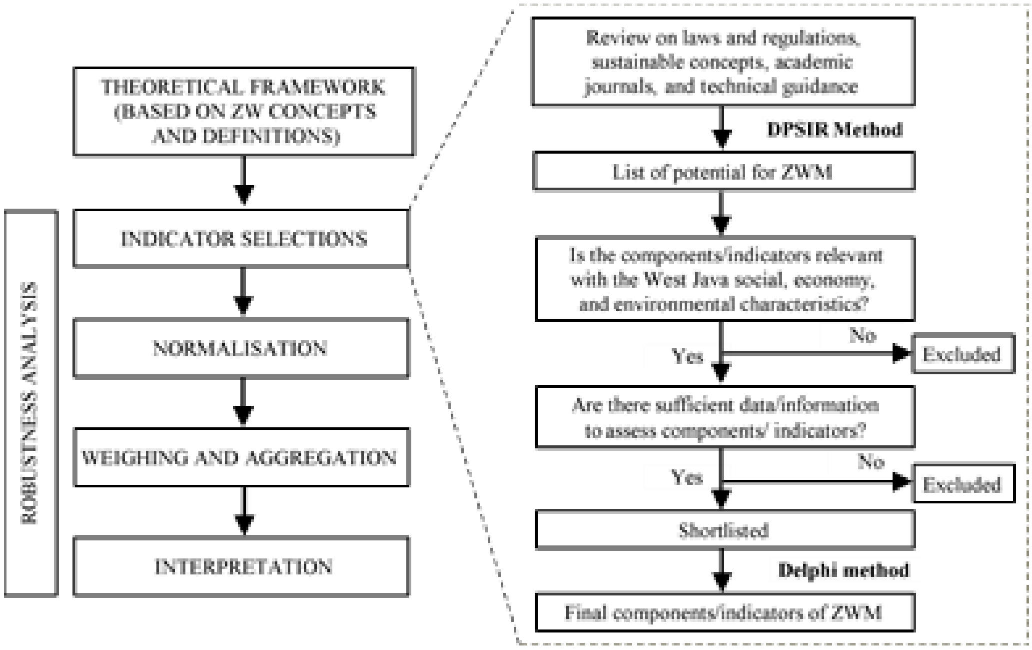

Figure 2. The proposed conceptual framework of WJWMI

By far,it is globally accepted definition and it implies that every stage in waste management strives systematically avoid and eliminate waste generation, conserve and recover all resources, and avoid to burn or bury them. Thus, sanitary landfill and waste to energy, even though both meet sustainable development principles, the two are not included as zero waste activities. As a consequence, in this study, WJZWMI will be developed through redesign, reuse, recycle and, recovery principles.

In line with the above definition, the conceptual framework also considers Law No. 18/2008 regarding Waste Management in Indonesia as a fundamental notion. Furthermore, Government Regulation No. 97/2017 regarding National Policy and Strategy of Municipal and Non-Municipal Waste Management that emphasize on two main strategies, namely (1) 30% reduction and (2) 70% treatment being directions for this development index is studied.

It is worthy to note that to obtain list of potential components and indicators (long listed), available waste indicators discussed in academic journals and technical guidance of waste management, are collected and considered to be used in the next steps in the development of WJWQI. Therefore, the accuracy of WJZWMI largely depends on a series of indicators that reflect the actual state of zero waste management across the province.

Two main criteria for identification of components and indicators are used. The first criterion was the suitability and the relevancy to the west java development with respect to the sustainable development of West Java(i.e. environmental, economic, social backgrounds). The second criterion was related to data availability of respective indicators for use in the case studies.

In general, the selected indicators are expected to be able to measure key performance indicators of zero waste management across the province. These can be either qualitative or quantitative forms over the facts of zero waste implementation. A few indicators in the WJWMI can be grouped as one components having similarities, or specific indicators can be merged as sub-indicators.

The selection of indicators can be a subjective process since there is no agreement among index developers regarding both the best method and approach used. Therefore, to eliminate subjectivity of the indicators selection, two additional methods are applied, namely the Driver-Pressure-State-Impact-Response (DPSIR) and the Delphi. The DPSIR is aimed at obtaining interaction among environmental, social and economic side [15]. Moreover, the DPSIR is used to describe the interlinked relationship between indicators and highlights the indicators which are needed to enable feedback on the resulting impact of current and future policy choices [16]. The latter is used to gain experts or related stakeholders 'opinions in finalizing selected components, indicators, and their thresholds for the development a composite index [17].Considering all available concepts and guidelines on zero waste management, a conceptual framework for West Java Zero Waste Management index was developed.

5. Preliminary results

The preliminary results only discussestwo steps in the development of the WJZWMI, namely the theoretical framework (presented earlier in Section 4) and two sub-steps of indicators selection. In the 2 sub-steps of indicators selection, related academic journals possessing highly cited in the period of 2012 – 2019, local regulations, and formal technical guidance were studied. Each indicator in those articles/documents/websites were collected and grouped using the DPSIR method. There are 168 indictors based on this extensive literature review, as presented in Table 2 Column 1 presents summarized long listed indicators using the DPSIR method and Column 2 shows scope of study and its references. While D/P stands for driving force/pressure, S/I is state/impact, and R is response.

Important indicators of zero waste can in general be classified as response indicators mostly. These important indicators are reduction activities prior to final or treatment processes. This indicates that either experts or decision makers provided policy and strategy to respond undesirable impacts based upon specific locations. The long listed indicators as presented in Table 2 addressed the importance of material flows clearly toward zero waste management as well as waste recovery being raw material for an input of previous stages of waste management cycle. In addition, even though landfill and waste to energy are excluded as zero waste activities, a few indicators are still used. Nevertheless, they are specifically considered as "negative factors" in the implementation of zero waste management.

Table2. Potential longlistedindicators

List of indicators		**References**
D/P	PDRB, types of city, waste generation, waste characteristic, coverage area, volume of waste.	Guidelines of regional SWM Scale: Provincial MSW
S/I	Landfill capacity, location of area.	
R	Segregation, container, collection, transportation, number of truck, number of temporary station, formal and informal activities, waste bank, number of employee, facility of waste treatment.	
R	Decreased of waste sent to landfill, decreased of waste generation treated in landfill, decreased of MSW, decreased of waste generation	Guidelines of local SWM Scale: City or regency MSW

	per capita, number of recycling at sources, number of reuse at sources, increased of waste generation segregated at sources, increased of waste to raw materials or energy, increased of number of waste processed to raw materials, increased of number of waste processed to energy.	
D/P **R**	Manufacturing, resource extraction and processing, consumption and waste generation, waste disposal. Product design, waste management, regulatory policy.	[18] Scale: Global MSW
D/P **S/I** **R**	Population, waste generated (ton), per capita waste generated (kg/cap), and per capita landfilled (kg/person). Waste diversion rate (%), per capita diversion rate (kg/cap). Waste composted (ton), waste recycled (ton), waste diverted (ton), and waste landfilled (ton), recycling (ton), compost (ton), and landfilled (ton).	[10] Scale: Australia MSW
D/P **S/I** **R**	Municipal waste generation (kg/day or m^3/day or ton/year), hazardous waste generation (kg/day or m^3/day), food waste generation (kg/day or m^3/day), construction and demolition waste generation (kg/day or m^3/day), amount of waste of electrical and electronic equipment (kg/day or m3/day) Number/ percentage of schools have implemented concept on waste (qty/%) Waste Prevention by reuse packaging (kg), waste prevention by reuse electronic equipment (kg), approach general waste prevention (kg), number/percentage of municipalities (qty), funding provided for waste prevention, number/percentage municipal statutes obliging, number of activities as part of the European week for waste reduction, facilities for the sale or exchange second goods, number of repair network of business, number of business conduct concerning resource material efficiency	[15] Scale: European MSW
R	Institutional, institutional structure, human resources, job desk, financing, capital, partnership, socialization, promotion, city waste bank integration, operational executor, collection, management, waste type, waste pick up, price fixing, operational time, monitoring, assessment, self-protection kits, work health and safety, waste bank client, community service, public facility, operational facility, building facility.	[19] Scale: City MSW
D/P **S/I** **R**	Population, income level (classified, $/cap), waste generation (Kg/Cap/day), municipal waste types (tonnes/year). Landfilled (%), incinerated (%), energy savings (GJHV/years), greenhouse gas (Kg/year), water (L/year). Recycled (tonnes), composted (tonnes), material substitution tonnes), material recovery (Tonnes).	[20] Scale: Global MSW
D/P **S/I** **R**	Material Use (ton/years), waste generation (ton/year), GHG from incinerator (%) (tCO_2), GHG from landfill (%)(tCO_2), carbon (tCO_2) Carbon increase (tCO_2), health (qty), and climate change. MSW reduce (ton/year), recycling Rate (%).	[21] Scale: Northern Spain
D/P **S/I** **R**	Industrial (Qty), e- waste generated (ton/years), transboundary movements (ton/years). Environmental quality (quality standards). Eco design (Qty), eco labelling (Qty), closed loop chain (Qty).	[22] Scale: Global SWM
D/P	Geo administrative area (km2), population in service area, No. of buildings (housing, inst., etc) (Qty), length of road network, household's purchase capacity, household expenditures, food consumption, resource consumption, consumption expenditure, economic cost, revenue, net cost benefit, waste properties (density, moisture cont, & chemical comp.), waste stream (household, C&I, C&D) (m^3/day), illegal dumping, environmental emissions (mg/L), amount of Waste (Qty), no. of employees (tonne)	[23] Scale: Global MSW

S/I **R**	Lifespan of landfill (year), diversion rate (%), net env. Burden/ benefit, no. accident in waste management (cases/ people), no. of health/disease related to waste (cases/ people) Area covered by waste service (m^2), types of Waste (MSW, C&I, C&D, e-waste, hard waste), avoidance programme, item exchanged/ resell (qty or kg), item reused (qty or kg), no. of bins, types of bins, size of the bins (cm3), types of waste collected separately (bin), frequency of collection (times/ day or per week), collected in formal/ informal, accessibility of recycling deport to public, recycled/cap, recycling efficiency, formal/informal recycling, materials processed in different facilities (kg), materials recovery (kg), sorting efficiency, controlled disposal, deposal/cap, environmental savings, waste management, H&S equipment for workers (person or people), central waste data, time series data, waste forecasting, regulatory scheme and program (CP, EPR), regulatory laws and rules (ban, restriction), incentives (tax, incentives), degree of public satisfaction (%), auditing and monitoring, export of waste (kg or tonnes or m^3), import of waste (kg or tonnes or m^3)	
D/P **R**	Per capita GDP, per capita economic benefits ($/person/year), per capita waste generation (kg). Per capita waste recycle (kg), per capita virgin material substitution (kg), amount of waste stream i managed by system j (tonnes), substitution factor for the amount of waste stream I managed by system j (tonnes), amount of waste avoided, recycled, treated, etc.) (tonnes).	[11] Scale: Global MSW
R	Preparing for reuse (waste mass wet basis), upcycling (waste mass wet basis), re-recycling (waste mass wet basis), composting and anaerobic digestion from source separation (waste mass wet basis), biological treatment of mixed/residual MSW (waste mass wet basis),waste to Energy (WtE) (waste mass wet basis), incineration without energy recovery (waste mass wet basis), landfill (waste mass wet basis), level of downcycling to the circular economy (CE), contribution level of biological treatment to CE, contribution level of WtE to the CE.	[13] Scale: MSW Portugal

This preliminary results also reveals that the long listed of key performance indicators are influenced by technical, institutional, community participation, regulation, and as well as regulation, in which zero waste management concepts and implantations can be also adopted in different scales, from city up to a country or continent. It is important to note that identification of existing solid waste management is needed to provide "benchmark" to evaluate the efficiency towards zero waste management. According to "this benchmark" policy intervention can be implemented using the selected indicators.

Taking account of the directions from policy and strategy of MSW mandated per regulation in each city across the province, namely 30% reduction and 70% treatment activities are a must. Thus, these two targets should be selected as mandatory indicators in the development of WJZWMI in the future.

6. Future works

This paper presented the proposed conceptual framework the development of WJZWMI for West Java. Having completing the literature review and long listed of potential indicators based upon the DPSIR method using two criteria namely the suitability of the proposed components and/or indicators with the relevancy to sustainable development aspectsand data availability, the preliminary results will be refined using the Delphi method inseveral case studies across the province. The application of the Delphi method aims at obtaining and consensus and eliminating subjectivity among stakeholders on the selected indicators. The Delphi will be also used to identify and define respective indicatorsthreshold values. After the finalisation of the components, indicators and threshold values, the method to aggregate the selected components and indicators will also be determined.

With respect to the case studies, the applications of the Delphi methodand the WJZWMI will be done in nine cities across the province, as this study will be focused on urban areas. The nine cities are selected as those have more comprehensive data. In addition, these cities produce mixed compositions of waste generation compared to those in rural areas.
The case studies conducted in nine cities, will start with data collection of the finalized set of components, indicators and threshold values. Using all relevant data collected from previous studies, formal databases and other related sources, the WJWMI will be applied for each area. One of the outcomes from these nine case studies is the prioritization of zero waste issuesacross the province, which will be the basis for recommendation for related authorities to improve their zero waste management in respective case study areas.
Finally, based upon input uncertainties, robustness analysis of the WJWMI will be undertaken through the inclusion or exclusion of components and indicators,the selections of threshold values, the normalization and the aggregation methods. The identified sources of uncertainty will be analysed through the sensitivity analysis to accurately point out how these different input assumptions affect the outputs. By taking account of this, uncertainties attached to WJZWMI in its development will be significantly reduced. Results of the robustness analysis will be used to finalize the outcomes of the case studies, so that recommendations can be conveyed confidently to the respective authoritiesin addressingzero waste issues within case study areas.

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