State of the art preliminary literature review: Sustainability and waste reporting capabilities in management systems

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216 PUBLICATIONS **3,468** CITATIONS

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21 PUBLICATIONS **306** CITATIONS

State of the art preliminary literature review: Sustainability and waste reporting capabilities in management systems

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Abstract. Inspired by previous studies research gap findings and limitations in management system functions to produce sustainability-related reporting authors set a goal to map the current academic literature in the context of waste management systems. The method chosen for the work was a systematic literature review, focusing on the Web of Science and Scopus databases. The authors found a total of 115 unique publications from the selected databases, which were filtered 28 contributing studies. With these studies, this study found that most of the publications are journals and almost half of the work has been published in the last 3 years. Additionally, sustainability and waste management reporting related literature seem to enjoy wide appreciation among the peers, indicated by a high number of references these publications had gathered. As an overall finding, the specific research area of waste management process quantified data reporting seems really young overall and needs additional research with multiple research gaps clearly waiting for follow-up research to pinpoint the specific areas to contribute in the near future. **Keywords.** Literature review, sustainability reporting, waste management system, systematic mapping study, digitalization.

1 Introduction

Industry 4.0, new technologies, and digitalization have been major drivers to accelerate changes in the last decade of human history. Globalization has led to unprecedented impacts on the environment and our globally shared natural resources [29]. The degradation of climate conditions, increased amounts of pollutions, and the rising demand for cleaner and renewable-based energy sources have pointed business owners the need to consider new ways to do their business for quite a time already [30]. As a result, companies have recognized a need to start changing the ways they operate. There are already good examples like Unilever, Starbucks, and Nike, with their brand integrated sustainability actions [31].

From a sustainability point of view, supply chains connect us to all assets this study use, making those globally highly important sectors to watch up, study [56], and improve [57, 58], as even when our word has gone through a huge burst of digitalization, industry 4.0 actions making industrial impacts to the global supply chains sustainability [32, 33]. Plus, the reduction of a need to possess physical materials (e.g., tapes, DVDs, paper, etc.) has

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limited logistics. But still, the logistics related premises alone form approximately 10% (300 CO_2 megatons) of global logistics and transportation sectors share from (2,800 CO_2 megatons) total yearly CO_2 emissions, which is around 5,5% of the global total [34]. Based on this data, supply chains highly contribute to our global emissions. Especially now, in Covid-19 pandemic time, when people stay away from physical shops and shop on-line instead, generating demand burst for warehousing, cross-docking, delivery center packets handling, and so on. A perfect setup to ask the question there is what sort of functions warehouse management systems have for sustainability matters reporting and how to decarbonize warehousing activities [35].

The aim of this research was to build on the path of previous research [36-38] painted by indicating research gaps in clearly a large global emission contributing sector. If so obvious area as logistics has shortages of literature in sustainability reporting, what is the case in the waste management sector itself? With the question in mind, this study wanted to map the academic literature situation in the waste management systems side and try to get a basic view of their capability to report sustainability-related matters. Considering the fact, that tools in use in the logistics sector cannot pinpoint and assess the amount of waste and inefficiencies in an explicitly quantified manner in a super competing sector like logistics, what really is the case with the waste management sector, which is handling the end of life of assets what sort of academic literature this study has available for the matter?

2 Method

Based on research findings in other research fields, authors decided to start a systematic literature review [39, 40] to work on a preliminary mapping of the current academic literature and views on waste management systems to report quantified waste stream data. For this task, a set of keywords was generated based on previous work results on other academics [41-43] and the authors' own experience. The keywords were used to find the academic studies reflecting waste management systems and calculations and/or their reporting capabilities to quantify and show up in numbers the amount of different waste components operations generate, handle and process upon activities the system can see.

For this set research goal, the following keyword combinations were used:

- "waste management system" AND sustain* AND report*
- "waste management system" AND environment* AND report*
- "waste management system" AND recycl* AND report*
- "waste management system" AND calculat* AND report*

With these keywords, two major academic databases (Web of Science and Scopus) were researched. With the databases, following results were found (Table 1).

Table 1. Preliminary results for databases, before filtering rules.

Keywords	Web of Science		Scopus	
	results	in english	results	in english
"waste management system" **AND** sustain* **AND** report*	28	28	53	53
57 unique from 81 total				
"waste management system" **AND** environment* **AND** report*	48	48	144	141
149 unique from 190 total				
"waste management system" **AND** recycl* **AND** report*	38	38	86	84
88 unique from 122 total				
"waste management system" **AND** calculat* **AND** report*	9	9	12	10
12 unique from 19 total				

Without filtering, the results were quite generic, including a lot of non-fitting results, and lastly, these software systems related studies started to focus on old things, in a sense how far software and software as a service have been developing lately. To focus on specific content contributing studies, with the databases, following filtering rules were used to get as well contributing results for the research goal as possible:

- not older than from 2010
- written in the English language
- not a report from national institutions, web pages, etc.

By applying the keywords into the selected two major academic databases, the following unique publications were found with different keyword combinations (Table 2).

Table 2. Results from the databases, after adding filtering rules.

Keywords	Results in english & 2010 - present			Total Unique
	WoS (CC)	Scopus	Sums	
"waste management system" **AND** sustain* **AND** report*	28	44	68	115
"waste management system" **AND** environment* **AND** report*	42	89	131	
"waste management system" **AND** recycl* **AND** report*	29	62	91	
"waste management system" **AND** calculat* **AND** report*	7	9	16	
Total sum of findings	**102**	**204**	**306**	

In the end, by combining the results to one review set, the given keywords, previously mentioned filtering rules, and the selected databases results combined produced 115 unique results. These academic literature sources were used to proceed to the content review phase of our literature study. The division of the publication channels for the found result is as shown in Figure 1. The publication channel classification is based directly on metadata received from the databases, is as follows:

PUBLICATION CHANNEL	NUMBER OF PUBLICATION
Journal Article	84
Conference Proceedings	15
Book Section	7
Book	9

Fig. 1. Number of unique publications found for review, from different publication channels.

To follow standard mapping steps, a review of found articles started based on their titles, abstracts, discussion, and conclusion chapters. Finally, the full text was reviewed to select the proper areas of specific studies. The filtering process resulted in 28 unique academic studies with the following distribution between publishing channels (Fgure 2):

PUBLICATION CHANNEL	NUMBER OF PUBLICATION
Journal Article	18
Conference Proceedings	5
Book Section	1
Book	4

Fig. 2. Found 28 articles publication channels distribution.

Table 3 presents the full list of studies selected for our follow up analysis for the state of academic research within the research area.

Table 3. Literature sources found for the mapping study.

ID/REF	YEAR	TYPE	TITLE	PUBLISHED IN	PAGES	DOI
[1]	2020	Journal Article	A nationwide assesment of litter China's beaches using citizen science data	Environmental Pollution	1-10	10.1016/j.envpol.2019.113756
[2]	2020	Journal Article	A step forward in quantifying the substitutability of secondary material in wate management life cycle assessment studies	Waste Management	331-340	10.1016/j.wasmnzuo.2020.07.015
[3]	2020	Journal Article	Assessment of COVID-19 waste flows during the emergency state in romania and related public health and environmental concerns	Int. Journal of Environmental Research and Public Health	1-18	10.3390/ijerph17155439
[4]	2018	Journal Article	Assessment ot Healthcare Waste Generation Rate and Its Management System in Health Centers of Bench Maji Zone	Ethiopian journal of health scuences	125-134	10.4314,/ejhs.v28i2.4
[5]	2020	Book	Assessment of Municipal Solid Waste Management in Jammu City: Problems, Prospects and Solutions	Lecture Notes in Civil Engineering	257	
[6]	2017	Journal Article	Assessment of the municipal sohd waste management system in Accra, Ghana: A "Wasteaware" benchmark indicator approach	Waste Management & Research	1149-1168	10.1177/0734242X17727066
[7]	2011	Conference Proceeding	Charactenzanon of Volume F trash from four recent STS missions: Weights, catagorization, water content	41st Int. Conf. on Environmental Systems 2011	1-12	10.2514/6.2011-5126
[8]	2020	Journal Article	Cross-regional mobility of construction and demolition waste in Australia: An exploratory study	Resources, Conservation and Recycling	1-14	10.1016/j.resconrec.2020.104710
[9]	2012	Journal Article	Development of solid waste prediction, characterization, and modeling tool for the assessment of manufacturing and service waste management systems	Journal 0f Solid Waste Technology and Management	38-87	10.5276/JSWTM.2012.38
[10]	2010	Journal Article	EASEWASTE-life cycle modeling capabilities for waste management systems	Int. Journal of Life Cycle Assessment	403-416	10.1007/s11367-010-0156-7
[11]	2015	Journal Article	Economic-financial analysis of the Italian packaging waste management system from a local authority's perspective	Journal of Cleaner Production	533-541	10.1016/j.jclepro.2014.10.069
[12]	2017	Conference Proceedirgs	Energy balance of waste management systems: A case study	IEEE Int. Conf. IEEM 2017	1495-1499	10.1109/1EEM.2017.8290142
[13]	2013	Journal Article	Establishing biomedical waste management system in Medical University of India - A successful practical approach	Clinical Epidemiology and Global Health	131-136	10.1016/j.cegh.2012.11.004
[14]	2015	Book	Evaluation of Current Laboratory Waste Management: A Step Towards Green Campus at Amirkabir University of Technology	Book: Implementing Campus Greening Initiatives	215-227	10.1007/978-3-319-11961-8_17
[15]	2020	Journal Article	Evaluation of household food waste generation in hanoi and policy implications towards SDGs target 12.3	Sustainability (Switzerland)	1-120	10.3390/su12166565
[16]	2014	Journal Article	Evaluation of life cycle inventory data for recycling systems, Resources, Conservation and Recycling	Resources. Conservation and Recycling	30-45	10.1016/j.resconrec.2014.03.011

[17]	2011	Book	Framework design for eco-industrial park's waste management system	Advanced Materials Research	808	10.4028/www.scientific.net/AMR.156-157.808
[18]	2016	Journal Article	Identification of decisive factors for greenhouse gas emissions in comparative life cycle assessments of food waste management - an analytical review	Journal Of Cleaner Production	13-24	10.1016/j.jclepro.2016.01.079
[19]	2014	Journal Article	Identification of key assessment indicators of the zero waste management systems, Ecological Indicators	Ecological Indicators	682-693	10.1016/j.ecolind.2013.09.024
[20]	2019	Book Section	Information System for Decision Support in Waste Management in the Arctic Region of Russia	Int. Conf. on Numerical Analysis and Applied Mathematics	1-4	10.1063/1.5114447
[21]	2020	Journal Article	Interactions of residential waste composition and collection truck compartment design on GIS route optimization	Waste Management	613-623	10.1016/j.wasman.2019.11.028
[22]	2020	Conference Proceedings	IoT based university garbage monitoring system for healthy environment for students	14th IEEE International Conference on Semantic Computing	354-358	10.1109/1CSC.2020.00071
[23]	2012	Book	Mathematical Model of Economics of Municipal Waste Management	Conference: Mathematica Methods in Economics 2012	823-829	NA
[24]	2010	Conference Proceedings	Modelling integrated Waste Management System of the Czech Republic	Int. Conf. on Systems	510-515	NA
[25]	2011	Journal Article	Quantification of greenhouse gas emissions from waste management processes for municipalities - A comparative review focusing on Africa	Waste Management	1585 - 1596	10.1016/j.wasman.2011.02.028
[26]	2019	Journal Article	Shaping and delivering tomorrow's sustainable municipal solid waste management system: Proposal for a structured data management infrastructure	Int. Journal of Environment and Waste Management	437-450	10.1504/1JEWM.2019.103646
[27]	2019	Conference Proceedings	Statistical analysis of determinant factors and framework development for the optimal and sustainable design of municipal solid waste management systems in the context of industry 4.0	Procedia CRP	245-250	10.1016/j.procir.2019.04.182
[28]	2018	Journal Article	Salas, Sustainability assessment of waste management system for mexico city (Mexico)—based on analytic hierarchy process	Recycling	1-18	10.3390/recycling3030004S

3. Results and discussion

Firstly, this study started with a comparison analysis to see how general keyword defining and areas specific research has been divided between publishing channels. For this study compared the previously found 115 articles, which were the unique articles found from the databases, matching into the selected keywords, with the screened and finally selected 28 publications. By comparing the results between the channels, it is evident that the topic is mostly in the interest of area-specific journals, whereas conferences and books are present as a minority with a large margin compared to journals. This could indicate that even when the amount of research is scarce, it is most likely high in quality and has been passed a fierce blind peer review process.

The authors analyzed the given research fields' academic output development for the last 10 years by mapping both the keywords matching 115 articles and the selected 28 study-specific articles publishing years. The general trend in the 115 keyword matching publications indicates growth in the academic output for the last 3 years (figure 3), in the general context of sustainability, waste management, and reporting & calculation studies.

YEAR	AMOUNT	YEAR	AMOUNT	YEAR	AMOUNT
2021	1	2017	11	2013	8
2020	18	2016	7	2012	6
2019	17	2015	10	2011	9
2018	17	2014	8	2010	5

Fig 3. Amount of keywords matching and base filtering rules matching 115 publications per year.

The data presented in figure 4 compares the yearly scientific output only within the selected 28 publications which shows a bit different story. The reporting and waste management systems related academic studies research area has been shown an increase in publication numbers basically just for the last year or so. This finding certainly indicates the lack of work and clear research gap in the topic area and is well in line with a similar gap found by the previously mentioned studies in the warehouse management systems sector [38].

YEAR	AMOUNT	YEAR	AMOUNT	YEAR	AMOUNT
2021	0	2017	2	2013	1
2020	8	2016	1	2012	2
2019	3	2015	2	2011	3
2018	2	2014	2	2010	2

Fig 4. Publishing years and amounts of publications specific to the research field.

The found 28 studies had 93 unique authors, from which only Christensen contributed more than one publication. He was one of the authors in publications [10] and [16]. Then by analyzing the found publications based on their publication channels, this study found three journals that included more than one article, contributing to the list of found 28 studies. Besides, Table 4 presents the journals and also the article references, published in these journals. All other studies were published in separate channels, in addition to journals, list included some conference proceedings, books, and book sections, without multiple contributing articles.

Table 4. Journals with multiple publications amount the found 28 studies

JOURNAL	AMOUNT OF STUDIES	ARTICLES
Waste Management	3	[2] [21] [25]
Journal of Cleaner Production	2	[11] [17]
Resources, Conservation and Recycling	2	[8] [16]

To analyze the academics' attention these areas specific 28 publications had received, a reference count analysis was made. This analysis is based on open public data released by Google Scholar [49]. The data is presented in following Table 5. Generally, the picture of these reference counts is quite revealing. All articles (seven of them) with a major amount of citations (25+) were published between the years 2010 and 2016, so they have had time to

receive attention from their specific audience. One should note, all of these were journal articles. This can be an indication that, even when the publication count is somewhat low, in this sort of topic area right now, at least the quality of the work is appreciated by the science community.

Table 5. Google scholar citation analysis for the 28 studies

ID	Type	Year	Citations		ID	Type	Year	Citations
[1]	Journal Article	2020	3		[15]	Journal Article	2020	0
[2]	Journal Article	2020	1		[16]	Journal Article	2014	62
[3]	Journal Article	2020	2		[17]	Book	2011	1
[4]	Journal Article	2018	5		[18]	Journal Article	2016	59
[5]	Book	2020	0		[19]	Journal Article	2014	102
[6]	Journal Article	2017	12		[20]	Book Section	2019	0
[7]	Conference Proceedings	2011	1		[21]	Journal Article	2020	5
[8]	Journal Article	2020	5		[22]	Conference Proceedings	2020	0
[9]	Journal Article	2012	2		[23]	Book	2012	8
[10]	Journal Article	2010	34		[24]	Conference Proceedings	2010	9
[11]	Journal Article	2015	26		[25]	Journal Article	2011	97
[12]	Conference Proceedings	2017	1		[26]	Journal Article	2019	0
[13]	Journal Article	2013	28		[27]	Conference Proceedings	2019	2
[14]	Book	2015	2		[28]	Journal Article	2018	9

Finally, analyzing the average number of pages in the studies, per publishing year, a trend of growth was noticed at the end of the decade (Figure 5). This seems to indicate that the latest studies are growing in amount contributing to this research area and getting more deep and holistic in their views into the topic context.
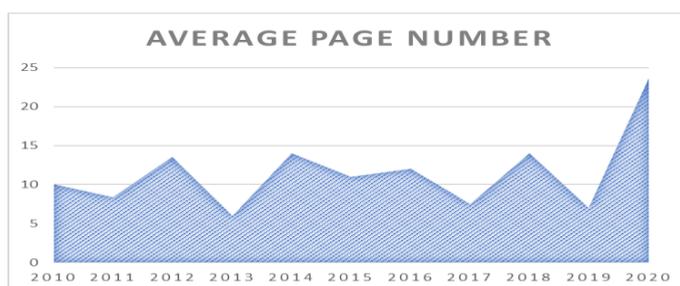

Fig. 5. Avera number of pages in the selected publication.

4 Conclusion

Considering the research aim, to map what sort of academic literature this study has available for the matter, the literature review shows a clear lack inside the waste management systems and reporting capabilities crosscutting research area. Only 28 area-specific publications were found from two of the largest research material databases (Web of Science and Scopus). In the findings, almost half (13) from the found topic-specific publications were published in

the last 3 years (after the year 2017) current academics are sort of pioneers in this multi-discipline research area. Especially, as roughly 30% of articles (8) were published in 2020, the findings indicates the research area to be extremely young and in need for additional work.

Given the lack of work in the waste specific data quantifying reporting management systems capabilities, authors suggest producing more systems related research and wide-scale scientific databases mapping studies to specify what exact areas have already started to receive academic contributions and where should be the largest research gaps. Also, big picture fleet-level studies [52-55] could be beneficial, as shown in this preliminary literature review. In this context, the journal articles are highly appreciated by other academics (a lot of references for a large amount of found studies). Most of the studies in this research area are journal articles given a sense of tight community of highly qualified researchers and scientists' contributions to the waste management and reporting context. Besides, three journals of Waste Management, Cleaner Production and Resources, Conservation and Recycling publishing more research than others in the identified 28 publications group. This study suggests research interested in contributing to this topic field to take a closer look at these journals to get a good starting point for deep insight into waste management topics and consider follow-up contributions. It seems only one author (Christensen) has contributed to more than an article, so there could be good academic career paths also available in this topic area.

As for future work, this study would like to suggest more practical studies on the current condition of waste management systems, software solutions offered for waste and sustainability-related operations reporting support, and benchmarking studies to clarify the current situation with the state of the art within different options available in need of tools to report different portions of materials waste streams of:

- private waste processing companies
- sustainability calculations consultation companies
- municipalities

Also, to speed up the software system and solution development efforts, authors would like to suggest trust [50] and knowledge sharing based industry-university collaboration models. For example models like hackathons [44-46], capstone courses [47], front-end innovation process formalization methods [51], plus digital citizen science [55] and community-based monitoring programs [48] as solution options to boost the design of environmentally more sustainable solutions [59].

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