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Review Paper

Urban Waste Management and Circular Economy in Bangladesh: A Systematic Review

Zobayer Ahmed*[,1], Md. Kamrul Hasan[2], Md Jahidul Islam[3]

[1]Department of Economics & Banking, International Islamic University Chittagong, Bangladesh; [2]Department of Public Administration, University of Chittagong, Chattogram, Bangladesh; [3]Department of Islamic History and Culture, University of Chittagong

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Abstract: The volume of solid waste is expanding in Bangladesh as the urban population grows. However, urban solid waste management is essential from a circular economy perspective. This study aims to conduct a literature review on urban solid waste management scenarios in Bangladesh from 1994 to 2022 and to offer suggestions for future studies. From SCOPUS databases, the research amasses 13 articles under PRISMA criteria for a systematic review. The analysis summarises the methodologies used in the studies, problems related to urban waste management and circular economy, policy suggestion toward waste management, and implementation of the circular economy. The analysis further reveals that most of the studies used a quantitative approach, and the origin of the waste management problems stems from governance, demographic, infrastructure, and cultural issues. Eventually, the policy suggestions also focused on public intervention, technological innovation, NGO involvement, infrastructure, and cultural issues of the stakeholders. The study uniquely presented the summary and synthesis of the sample papers to identify future research streams.

Keywords: *Circular economy, Chittagong (Chattogram), Dhaka, Urban Waste, Waste management.*

Introduction

Waste management in urban areas is different from rural areas around the world. Because cities are more crowded and people living in the cities lead a busier life compared to villages. Eventually, systematic waste management is important for green city life (Mingaleva *et al.*, 2019; Tehrani *et al.*, 2020). From various environmental and sustainable development perspectives, waste management both in urban and rural areas, requires special attention.

Bangladesh is considered one of the most compactly populated lands in the planet (Rahman *et al,* 2021). Among the major cities, Dhaka and Chattogram (previously spelled-Chittagong) are the most populated cities, with per capita waste generation of 0.56 kg and 0.48 kg, respectively *(Enayetullah et al.,* 2005). Dhaka is considered as one of the quickest-expanding megacities in the earth with a large population remains environmentally unconscious. Consequently, of solid wastes in Dhaka, Khulna and Barishal 40%, 52% and 56%, respectively are found on public places or roadside (Planning Commission, 2015), triggering urban pollution, blocking drains and creating public health risks (Planning Commission, 2013). Considering the circular economy of Dhaka, solid waste management is a major challenge (Akther, Ahamed, Noguchi, Genkawa, & Takigawa, 2019). Moreover, the population density in these two cities is 36941 and 19800 per square kilometer in Dhaka and Chattogram, respectively. With a PM (particulate matter) 2.5 concentration**,** which is currently 12.2 times the WHO (World Health Organization) annual air quality standard value, Dhaka is the second most contaminated city on the earth after Delhi in India (IQAIR, 2023).

Rapid growth of the urban population has been one of the reasons for air pollution (Alam *et al.*, 2013). Moreover, the environmental quality of the cities in Bangladesh is extremely miserable. Natural environmental aspects like water bodies, green spaces, vegetation etc. are in vulnerable conditions as always; the real-estate agencies are trying to construct various residential, industrial and commercial infrastructure through unlawful ways, going against the Dhaka city master plan (Islam *et al.*, 2018).

To ensure a sustainable urban environment and circular economy, waste management in these two cities has been studied thoroughly by researchers from various academic disciplines, including

*Corresponding: E-Mail: ecozobayer@gmail.com ;

environmental science and engineering, social sciences, and biological and medical sciences. Appropriate management of municipal solid waste is critical for reducing environmental health effects and the ruin of land resources. Therefore, the choice of sustainable waste management approaches is very influential for urban development. However, technologies should be sustainable in the long term to ensure a circular economy model (Ahmed *et al.*, 2022; Akther *et al.*, 2019). Consequently, the environmental policymakers of Bangladesh are recommended to apply and adjust the necessary and positive procedures to take advantage of the technical impact of FDI (Foreign Direct Investment) completely to ensure a sustainable environment (Firoj et al., 2022). Eventually, the findings and recommendations made in different research require synthesis and summarizing to ensure a better understanding of waste management scenarios in the urban areas in Bangladesh. However, from the policy perspective, no significant improvement is visible.

The present study thus aims to review the literature published in SCOPUS-indexed journals on waste management connected to circular economy. Such systematic review helps future research and policy formulations regarding urban waste management in developing countries in general and Bangladesh in particular.

The paper is structured in five sections. Following an introduction, the second section provides the detailed methodology of the literature review. The next sections present the findings in detail, followed by the discussion and future research agenda. Finally, the paper ends with a conclusion section.

Method

The aims of the study, the selection criteria and eligibility, the strategy for searching, and the collection method, the methodology of the review and the inclusion criteria are important to find the gaps in existing literature (Tranfield *et al.*, 2003). Additionally, the literature review classifies and summarizes prevailing studies based on main topics and suggests for future works (Kabir Hassan *et al.*,2023; Seuring *et al.*, 2005). Present study uses a systematic approach to review available literature based on content analysis. In essence, the study used a four-step process that included finding the data, screening initial data, determining suitability, and adding the data. The study gathered data from the SCOPUS database only. Because, the SCOPUS database has been thought as a trustworthy database by many researchers (Fahimnia *et al.*, 2015; Malviya *et al.*,2008).

Identification of the data

The information was collected from the integrated SCOPUS databases, which also included the major publishers Willey, Emerald, Sage, Elsevier, Springer, and Taylor & Francis. While the key justification for selecting this database is that many prior studies (Alshater *et al.*,2021; Hassan, *et al.*, 2022; Shah, *et al*., 2021; Zainuldin & Lui, 2022) focused more on it. The additional determinants are given underneath:

1. It is the most extensive gathering of peer-reviewed interdisciplinary databases in social sciences.
2. The database also keeps higher-quality documents relative to many accessible alternative databases.
3. The documents that cover selected keywords as per the study objective are included in this study. The paper's title, abstract, and keywords made up the sole set of first search terms. Initially, 11397 publications were found by utilizing different keyword combinations. Table 1 displays the summary of the data collection process.

Screening initial data

The primary search result includes books, conference papers, and book chapters in addition to the articles, all but the articles were later omitted. As a result, the search was narrowed down to "articles" to exclude only books, conference papers, and magazines from the search output. Eventually, after initial refinement, 5540 documents remained as articles.

Determining eligibility

This systematic review took into account all types of research approaches. Review articles were excluded but were screened for any information relevant to this review. This systematic review excluded all non-English studies, and articles published between 1994 and 2022 are included in the search. Moreover, due to the unavailability of full texts, the study excluded some other articles.

Table 1. Data collection using the PRISMA method

Step	Searching process	Number of documents=n
Identification	Through SCOPUS database searching	11,397
Screening	Only the research articles	5540
Eligibility	Assessing full-text articles for eligibility	471
Inclusion	Qualitative synthesis	13

The insertion of data

For the purpose of metadata analysis, the review article included 13 documents from the Scopus database. Consequently, the researchers confirm that the information is derived from reliable sources. Additionally, because it indexes journals from other major databases such as Taylor and Francis, Science Direct, Emerald, Elsevier, Wiley, Springer and many more, these databases are suitable for descriptive purposes. In order to present insights and future information, however, the information should be derived from more reliable sources. Lots of former researchers accepted the data for offering the understanding by subjective judgment (Fahimnia *et al*., 2015; Malviya & Kant, 2015). However, 13 papers from reputable journals and authors were objectively chosen for the current investigation. Therefore, data from Scopus was collected only through keyword search to ensure that they were coming from a rich data source and to maintain an unbiased sense of the study. It is important to note that Scopus also includes papers that are indexed by search engines. Table 1 shows the summary of the data collection process.

Findings

This section presents the findings of the systematic review of the literature. We basically reviewed the methodology used in the study, the origin of the waste management problem, policy recommendations and the future research scopes available in the sample articles. The summary and synthesis have been presented in different tables under the following sub-sections.

The methodology used in the studies

The methodology was found among 13 research papers about various research methodologies used by researchers, such as quantitative, qualitative, descriptive, empirical, and mixed-method types (Table 2). Almost 85 percent were quantitative, with the remaining 15 percent being other types. Different types of samples were used in research sampling by different professionals. Mohammad Sujauddin (2008), used the large sample size of 8w = 3500 people, whereas Islam et al. (2018) used 54 wards. The questionnaire and survey method collected the most data. Observation, interviews, random sampling, and other methods are commonly used by researchers. Table 2 presents the summary of the methodology used in the sample studies.

Origin of the waste management problem

Table 3 summarizes all the related information about the nature of the problem and limitations of governance; it was found 22% of the governmental problem is in the waste management system. However, the maximum researcher found the demographic or population problem is a big implication for waste management systems; about 25 % of the problem is related to the population. Infrastructural fragility shared 28% problems in this research. And Cultural issues of the stakeholders' such as unawareness of home and industrial activities, sanitation, drainage, and waste dumping on the roadside, also have implications for waste management which is 25%.

It was found from Table 3 that the study reveals maximum researcher, about 32% think the government should come forward first sustainable waste management. The non-governmental organization (Vernengo & Nabar-Bhaduri) recommended waste policy making 15%. Demographic was the least recommended, which is 8%. Infrastructural development of the formal and informal sectors 27% must be promoted. The rest of the thinkers recommended Cultural issues and the mind of the stakeholders should be changed, which is 18% think.

Table 2. Methodology used in the sample articles

Author and Year	**Research type**	**Sample size**	**Data collection tools**
Kakon, Harisah, Mishima, & Begum, 2016; Rampley et al., 2020)	Quantitative	Seventy-eight water samples were collected from the Turag-Tonga-Balu and Turag-Buriganga rivers.	Temperature, turbidity, dissolved oxygen (DO), ammonia, nitrate, and total coliforms are being measured in samples (TC)
Kakon et al., (2016)	Quantitative surveys and descriptive	200	Questionnaires, interviews, and observation
Zebunnesa Rahman, Siwar, & Begum, (2017)	Empirical,	436	Structured questionnaires and stratified random sampling were used.
Alam & Mosharraf, (2020)	Quantitative	110	Observational
Islam et al., 2018)	Quantitative	54 wards	inter-ward comparison and overall environmental condition assessment
Bhowmik, Saef Ullah Miah, & Mohaimen Bin, (2020)	Quantitative	514 urban areas	Survey
Sujauddin, Huda, & Hoque, (2008)	Quantitative and Qualitative	8w=3500 population	A pre-tested structured questionnaire, literature review
Masum, Hossen, & Pal, (2020)	Quantitative	The area is approximately 8.6 Km2 (857.8 ha), with a slope of 16% from upstream to downstream.	Cross-section, side slope, bottom slope, bottom materials, tide level, canal discharge, and various types of land use land cover (LULC), flow path, and so on.
Mahmudul Alam, Hossain, Islam, Murad, & Khan, 2021)	Quantitative and Qualitative	74 street children	random sampling, interviews
Jakariya, Housna, Islam, Ahsan, & Mahmud, (2018)	Quantitative		investigative and descriptive
Hassan, Ahmed, Rahman, & Biswas, (2008)	Empirical	60 Health Care Establishments (HCE).	Observation, questionnaire survey and formal and informal interviews.
Ahmmed, Arif, & Hossain, (2020)	Quantitative	225 households	primary data survey, interviewed by a stratified random sampling
Alam & Ahmad, 2013)	mixed method	100 plot buyers	Survey, report

Policy recommendations

Out of the 13 articles, all of them directly provide guidance for adopting urban waste management policies. We have categorized the policies into six categories that are related to governance, NGO (Non-government organization), demographic, technological innovation**,** infrastructure, and cultural issues of the stakeholders. Table 4 provides a summary of the policy recommendations made by the authors.

Table 3. Origin of the waste management problem

Author and year	Governance	Demographic	Infrastructure	Cultural issues of the stakeholders
Rampley et al., (2020)		√	√	√
Kakon et al., (2016)	√	√	√	√
Zebunnesa Rahman et al., (2017)		√		
Alam & Mosharraf, (2020)			√	√
Islam et al., (2018)	√	√	√	√
(Bhowmik et al., 2020)		√	√	
Sujauddin, Huda, & Hoque, (2008)	√			√
Masum et al., (2020)		√	√	√
Mahmudul Alam et al., (2021)		√		√
Jakariya et al., (2018)		√	√	√
(Hassan et al., (2008)	√		√	
Ahmmed et al., (2020)		√	√	√
Alam & Ahmad, (2013)	√		√	

Table 4. Policy recommendation for waste management

Author and year	Governance	Technological innovation	NGO	Demographic	Infrastructure	Cultural issues of the stakeholders
Rampley et al., (2020)	√	√				
Kakon et al., (2016)	√				√	√
Zebunnesa Rahman et al., (2017)	√	√				√
Alam & Mosharraf, (2020)		√		√		
Islam et al., (2018)	√				√	√
Bhowmik et al., (2020)		√			√	
Sujauddin et al., (2008)	√		√			
Masum et al., (2020)	√	√			√	
Mahmudul Alam et al., (2021)	√		√	√	√	
Jakariya et al., (2018)	√	√	√		√	√
Hassan et al., (2008)	√	√	√			√
Ahmmed et al., (2020)				√	√	√
Alam & Ahmad, (2013)	√	√	√		√	

Discussion and future research agenda

Most of the studies used quantitative analysis of waste management by surveying the related stakeholders. However, there is a possibility of providing artificial information or biased data during quantitative surveys (Choy, 2014). In such cases, regarding the study of the behavioural pattern of the stakeholders and to reveal the real scenario, qualitative data can be more useful in understanding the behavioural pattern (Kelle, 2006). As per the analysis of the origin of the problems in waste management and circular economy, the majority of the studies focused on infrastructure-related difficulties. But public infrastructure in an urban area is provided by the public authority- the municipality that has some other bottlenecks (Cao *et al.*, 2020). It is evident that in Bangladesh, public authorities, especially those who work on infrastructure development projects, have more scope for getting involved in corruption (Ahmed et al., 2022; Zafarullah & Huque, 2021). Moreover, public officials suffer from lack of motivation, lack of technological adaptation and innovation.

Table 5. *Future research directions*

Author and year	The future research scope(s) mentioned in the article	Possible future research direction
Rampley et al., (2020)	The temporal and spatial dimensions of metal pollution in complex river systems may be usefully linked with public health considerations to improve human welfare and achieve SDG 6.	To do more research on how to remove pollution from the three rivers, Buriganga Turag and Balu, which are inside Dhaka.
Kakon et al., (2016)	In the future housing policy of the country can be properly addressed.	Future research can determine the level of environmental and waste management awareness among garment workers.
(Zebunnesa Rahman et al., 2017)	Making policies that train people to work with waste could be a helpful step toward establishing a waste management system in Bangladesh that is both sustainable and effective in the long-term.	Other than training policies, awareness campaigns and related policies can be addressed in future to ensure circular economy policies.
Alam & Mosharraf, (2020)	The study has some limitations, but it offers the baseline data for future research on similar topics.	In the future, research might be done to figure out how to recycle medical products and drugs in the Bangladesh context.
Islam et al., (2018)	Future studies may focus on urban planners and authorities to understand the other reasons behind the deterioration of the environment.	In the near future, an in-depth discussion on the environment and the waste management system to remove unhealthy policies and malmanagement can be addressed through research.
Bhowmik et al., (2020)	The combination of waste management and the Internet of Things can provide a technologically savvy perspective that will improve waste management system in future.	Future research may focus on defining the optimum technology in waste management since Bangladesh as a developing country, has labour abundance and some technologies make people unemployed.
Sujauddin et al., (2008)	This study can be repeated throughout the year to provide a complete picture of the household solid waste situation.	Socio-economic parameters of the households, as well as an examination of management practices, with the goal of locating problems and determining potential solutions, can be focused on in future research.
Masum et al., (2020)	Future studies may focus on how local policymakers manage the city's drainage network, which is inadequate due to unplanned urbanization, solid waste disposal concerns, and lack of operation and maintenance.	Planners may pay attention to how the policy is put into place in urban areas to deal with the amount of runoff in a way that takes water quality and amenity values into account.
(Mahmudul Alam et al., 2021)	Not available	Further research may focus on sustainable waste management and preventing waste collectors' health.
Jakariya et al., (2018)	Future research can address the management of mud and its sustainable recycling.	Other issues related to drainage can be addressed in future research.
(M. M. Hassan et al., 2008)	Source-driven waste isolation and its impact could lead to more efficient urban waste management in future.	Future research can focus on medical waste mismanagement, raising awareness, and implementing appropriate policies and laws.
Ahmmed et al., (2020)	Research that is based on source-based waste segregation and its effects has the potential to result in a waste management system that is superior and more effective.	It will be essential to examine system performers and incentivize a path toward sustainable solid waste management without threatening existence and livelihood.

Since corruption is linked to governance, it requires prevention to implement development projects effectively (Khan, 2006). If corruption is prevented, better infrastructure can be constructed within the given public allocations. As we see from the analysis of the policy recommendations in the selected articles focused chiefly on governance issues. Moreover, some articles suggested the involvement of NGO sector in waste management. A few suggestions are related to demographic issues and cultural issues of the stakeholders. Table 5 illustrates the summary of future research streams.

As per the Table 5, we see some studies make explicit indications of future research. Besides, in the last column, the researchers provide a more concrete idea for next research issues. Many of the future research streams focus on the appropriate policy formations regarding awareness, training and waste management to ensure a sustainable environment and circular economy. A few studies emphasize the adoption of optimum technologies to prevent unemployment. Recycling methods and processes for more efficient waste management are focused by some researchers.

Conclusion

Due to the increase in population and the expansion of industries, human and industrial wastes are increasing daily, which is seriously affecting the environment. Although people and factories are still much more environmentally conscious than earlier, there are still opportunities for improvements in various aspects. This study aims to know the position of waste management in Bangladesh through a systematic review of existing literature. For this, we selected 13 articles and analyzed them rigorously. The study findings initially focused on the methodology used in various studies. Most of the studies are based on primary data collected through a survey and applied qualitative analysis. As per the sample articles, the waste management problem, and the barriers to adopting a circular economy originate from the governance, demographic, infrastructure and cultural issues of the stakeholders. Among the sources, the majority of the factors are related to demographic and infrastructure development. Based on the recommendations proposed by the sample articles, the cities' local governments are advised to take appropriate policies related to the governance, demographic, infrastructure, innovation and cultural issues of the stakeholders. The study is based on the SCOPUS database only. Moreover, due to accessibility limitations, the authors had to rely only on the sample articles collected for this study. Since there are fewer publications from Bangladesh in SCOPUS databases, a bibliometric review can be conducted for publications from all over the world.

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