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Circular economy model and sustainable development nexus in Bangladesh

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Abstract: The practice of circular economy (CE) is rare and limited to recycling in the economic sectors of Bangladesh. The present study aims to understand how currently these practices are related to Sustainable Development Goals (SDGs). To meet the research objective, both primary and secondary information have been used. The study reveals that there has been an increase in the trend of research regarding CE and sustainable development in Bangladesh from the year 2019. Furthermore, the practices of selected sectors were helping to achieve SDG 7 (affordable and clean energy), SDG 8 (decent work and economic growth), SDG 9 (industry, innovation and infrastructure), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), and SDG 15 (life on land) to a certain extent. Nevertheless, widespread challenges exist, including lack of capability, research, administrative efficiency, efficient policies, and many more, in implementing CE practices to help achieve SDGs in Bangladesh.

Keywords: circular economy; sustainable development; wastage; environment; Sustainable Development Goals; SDGs; Bangladesh; recycling.

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1 Introduction

The production-to-consumption stages occur in two major economic models from the sustainable development perspective – linear economy and the circular economy (CE) (Figure 1). In the present world, the production system involves three major stages – production, consumption and waste disposal. This is known as the linear economy model. However, bringing the wastes into a new production process, widely known as recycling, makes the economy's production system circular. Thus, the CE model involves production and consumption in a sustainable manner such that a minimum amount of the environment is polluted. Moreover, the waste produced needs to be as minimal as possible, and those wastes should be recycled for further production. Such that, the 3R strategy (recycling, reduce and reuse) are fundamental to the concept of this model (Manickam and Duraisamy, 2019).

CE and sustainable development go hand in hand. As literature depicts the relationship of CE practice with some of the Sustainable Development Goals (SDGs): clean water and sanitation (SDG 6), affordable clean energy (SDG 7), reasonable consumption and production (SDG 12) and life on land (SDG 15) (Schroeder et al., 2019).

In affluent nations, the CE concept is frequently used from a sustainability standpoint. Some of the prevalent CE practices in the USA include creating carpets out of plastic, recycling and reusing discarded clothing, and building homes out of old shipping containers. Besides the USA, Sweden recycles and repurposes discarded clothing, the UK creates plastic roads, Poland creates biodegradable silverware, and France employs the CE principle throughout phases of agricultural production. Additionally, some of the most popular CE practices can be found in: Australia, where leather bags are made from fish skin; in New Zealand, where carpets are made into bicycles; in Japan, where discarded garments are recycled, and in Singapore, where food waste is utilised to make fertiliser. In order to protect environmental quality, apart from the CE practices, the use of renewable energy is also increasing across the globe (Bozkaya et al., 2022).

Being a developing country (Ara et al., 2015), Bangladesh also has some degree of CE applications from a sustainable development perspective (Azizuddin et al., 2021). However, Bangladesh requires a large volume of industrial investments to meet the SDGs by creating huge employment opportunities (Khatun et al., 2018). In such cases, the CE model that incorporates the 3Rs (recycle, reduce and reuse) principle may be a more feasible option (Yong, 2007). For this, in the context of Bangladesh, a scientific investigation of the practices CE model relating to sustainable development is crucial for achieving SDGs in Bangladesh.

The present study thus intends to address the applications CE model concerning SDGs in Bangladesh. The current study is descriptive in nature, incorporating qualitative and quantitative data gathered primarily from secondary resources, along with a few interviews conducted with people having experience in the related field. The following sections provide the details of the literature review using the bibliometric analysis and review of the literature concerning CE and SDGs in Bangladesh. Then, comes the methodology section, followed by a discussion of CE practices in Bangladesh related to the SDGs and the setbacks. Finally, the paper ends with the conclusions section with a brief overall discussion.

2 Literature review

The SDG and CE literature, in general, and specific to Bangladesh, has been discussed in the following three stages:

- a SDGs in Bangladesh: a bibliometric analysis
- b CE in Bangladesh
- c CE and SDGs in Bangladesh: combined literature.

Figure 1 shows how the linear economy model [Figure 1(a)] and the CE model [Figure 1(b)] function in an economy.

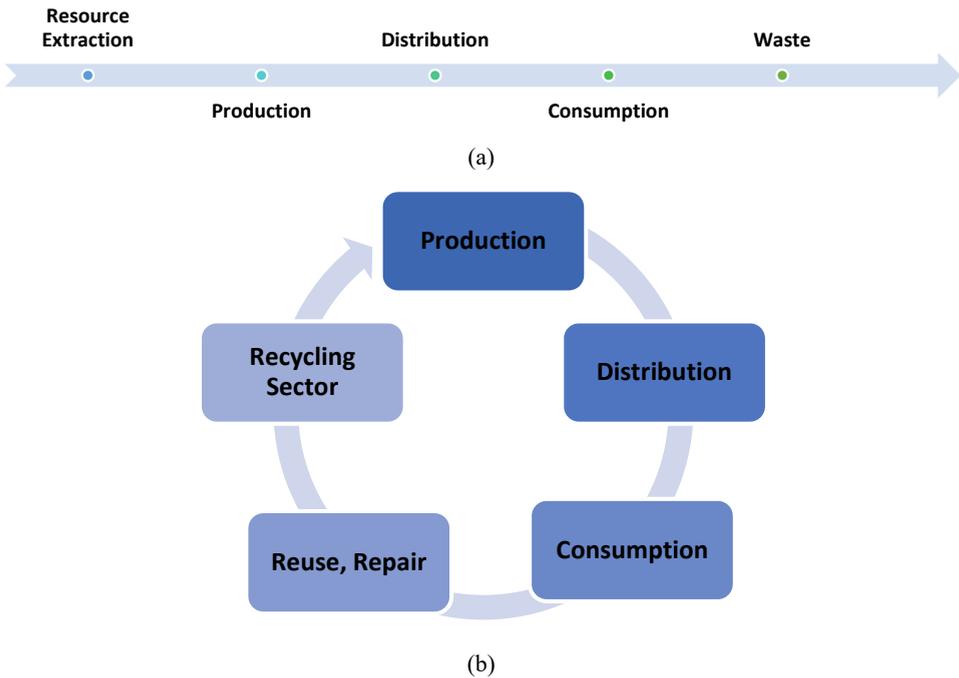
2.1 SDGs in Bangladesh: a bibliometric analysis

As per SCOPUS database, we have analysed 111 documents that have either ‘SDG’ or ‘sustainable development’ and ‘Bangladesh’ in the title. Using R-shiny of the R-programming, the bibliometric analysis reveals some fact regarding the SDG related research in Bangladesh.

Figure 2 shows the number of publications over the years since 1992. The line graph illustrates that before 2019, the number of publications was in the single digits. But in 2019, it increased dramatically and continued a constant upward trend. The average trend line also shows upward-sloped progress.

Figure 3 depicts the types of publications on SDG and sustainable development in Bangladesh. The majority of the publications, more than two-third, are journal articles. Nearly 10% are conference papers followed by 8% review articles. There are only 7% book chapters and 1% books on this topic.

Figure 1 Linear economy model and CE model, (a) linear economy model (b) CE model (see online version for colours)



Source: Ahmed et al. (2022)

Figure 2 Publication trend (see online version for colours)

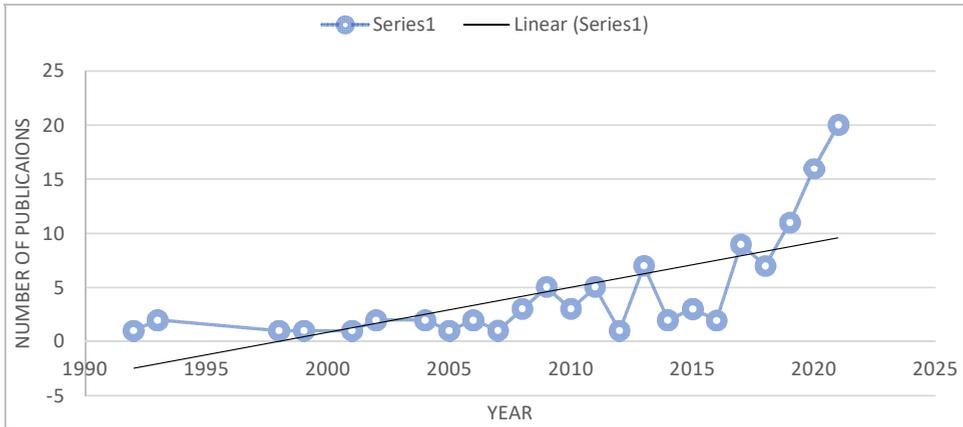


Figure 4, the second largest (23.4%) research has been conducted in the environmental sciences. The next three categories are energy (10.8%), agriculture and biological sciences (7.2%) and engineering (6.8%). Economics, econometrics and finance cover only 5% of the total publications related to SDGs and sustainable development in Bangladesh.

Figure 3 Publication types (see online version for colours)

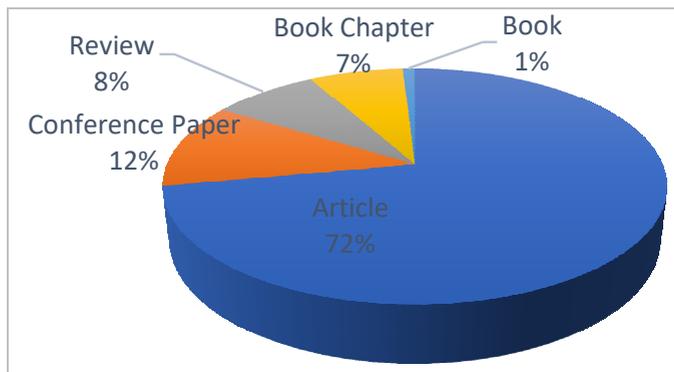
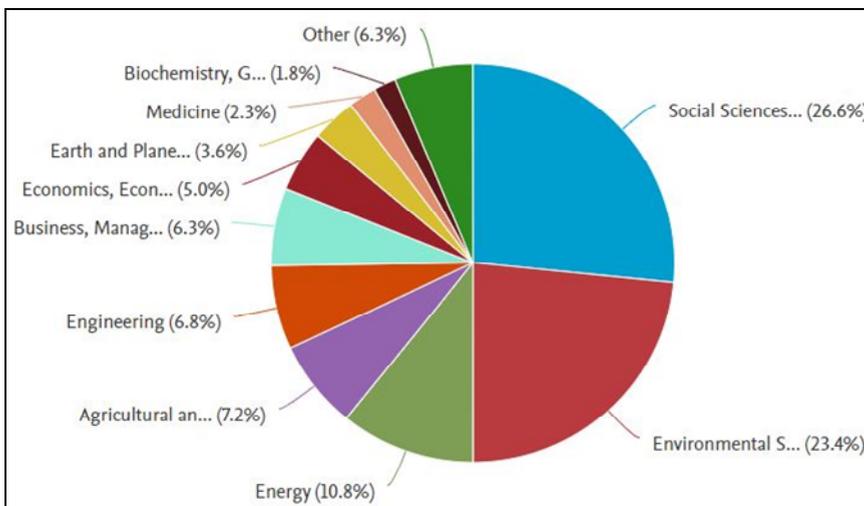


Figure 4 Publication categories (see online version for colours)



Among the publication categories, one-fourth (26.6%) of the research related to SDGs and sustainable development in Bangladesh comes from the social sciences.

The trend topic analysis (Figure 5) shows that, in the earlier years of the 21st century, the major trend topics were groundwater and rural development. During this period, the arsenic problem was discovered in the rural areas of Bangladesh. Eventually, the major research focus was on groundwater and rural development. However, later on, from 2010 to 2012, the research concentration shifted to sustainability and solar energy basically. In recent years, sustainable development received the highest focus, followed by environmental protection, climate change and SDGs.

The word tree map in Figure 6 shows the percentage of the keyword used in the sample research documents. Nearly one-fourth of the documents have the keyword ‘Bangladesh,’ and 20% has the keyword ‘sustainable development’. The next four frequently used keywords are ‘planning’, ‘sustainability’, ‘climate change’ and ‘economics’ as shown in the second column of Figure 6.

Figure 5 Trend topics (see online version for colours)

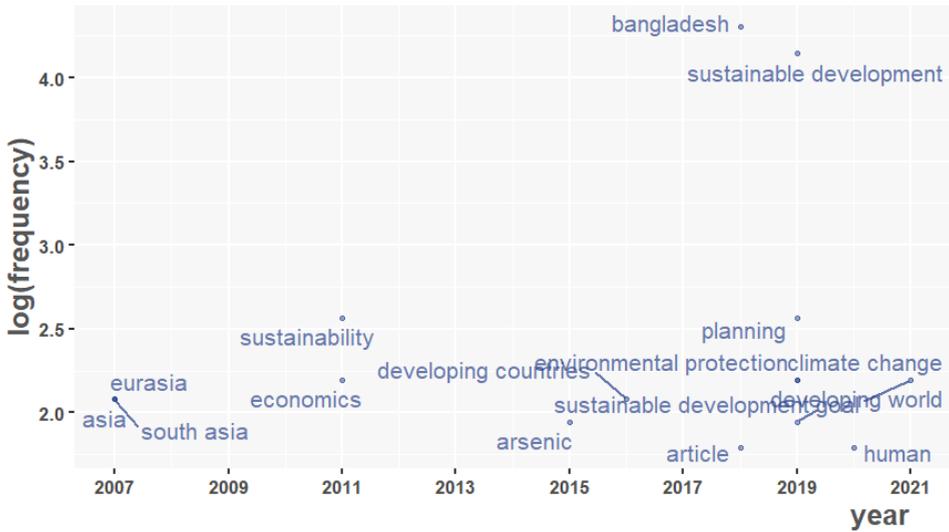
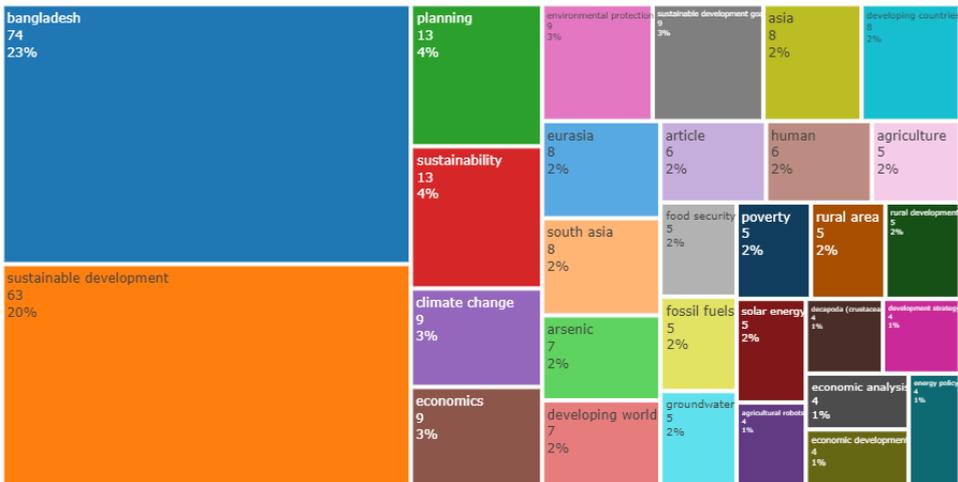


Figure 6 Word tree map (see online version for colours)



2.2 CE in Bangladesh

In Bangladesh, recycling is the most widely practiced component of the CE concept. The concept of reuse, on the other hand, has gained traction among Bangladesh’s common people in recent days, with re-commerce operations on Facebook assisting in breaking down the using second-hand goods’ stigma (Arman and Mark-Herbert, 2021).

Many firms and producers are also involved in conserving resources and producing less trash (Ahmed et al., 2022). However, when compared to the garbage generated, recycled waste may be minimal.

The garbage created in cities is normally collected by the urban poor, and this is one of the important stages for collecting wastes, in order to recycle, which is one of the most popular recycling techniques. In the capital city of Dhaka solely, 0.12 million poor people are directly or indirectly involved in rubbish recycling. Around 522 cities and towns in Bangladesh produce and dump 13,332 tons of rubbish every day, totalling 4.86 million tons per year, causing serious environmental degradation (Chowdhury et al., 2014).

However, garbage collection efficiency in diverse Bangladeshi metropolitan regions was found to be on average 55%, which is insufficient for creating an environmentally friendly metropolis. As a result of the continual generation of waste, Bangladesh's Government launched the 3R waste management policy in 2010. Its goal is to reduce waste output and encourage waste recycling. In 2005, the United Nations Development Programme (UNDP), Sustainable Environment Management Programme (SEMP), and Ministry of Environment and Forests (MoEF) collaborated to construct a recycling training centre to educate various professional groups on garbage recycling and energy conservation (Ministry of Environment & Forests of Bangladesh, 2010).

2.3 CE and SDGs in Bangladesh: combined literature

Based on a systematic review of the CE and SDGs nexus, Dantas et al. (2021) argued that CE and Industry 4.0 nexus is crucial to reach the SDGs. Recently, some studies have focused on both the CE and the SDGs in Bangladesh. Among them, the latest one is conducted by Azizuddin et al. (2021). Although they studied CE practices and the SDGs nexus in Bangladesh, they focused basically on government policy issues. Moreover, they did not concentrate on the challenges of achieving both the CE and SDGs. Akter et al. (2022), however, focused only on the apparel sector with SDG 12. Moreover, their study proposed a conceptual model to achieve SDG 12 following the CE model.

The above analysis on CE and SDG nexus in the case of Bangladesh reveals a gap in the existing literature that requires a wider investigation into the relevant sectors. The present study thus aims to fulfil the missing link.

3 Methodology

The study depends mostly on secondary data. Moreover, primary data was gathered from selected Bangladeshi experts and professionals in the field of the environment following the qualitative data collection tool – key informant interviews (KIIs). In contrast, secondary data sources include published records of numerous companies and factories along with journal articles, magazine articles, editorials, newspaper articles and grey literature. Moreover, in the literature review, more recently published (2018–2022) articles from the SCOPUS were collected on 1 May, 2022 for bibliometric analysis. The analysis of the study depends mostly on descriptive analysis. The applications of the CE model in various production sectors in Bangladesh concerning SDGs, with relevant facts and figures, have been presented in a tabular form. However, the qualitative data collected from primary sources is presented in the content analysis method. The research's ethical principles have been properly enforced. KIIs were informed at the start of the conversations that the data and information collected would be used purely for

research purposes and that there would be no damage or benefit to the respondents. Pseudo-names have been used for persons who refused to have their names published.

4 CE practices in Bangladesh related to SDG

CE practices and SDGs have bidirectional beneficiary properties, SDGs were seen to be helping the implementation of CE practices, as well CE practices tend to accelerate the achievement of SDGs (Azizuddin et al., 2021). The Government of Bangladesh has taken the initiative to fulfil SDG 2030 by complying with CE principles. In total, SDGs has 17 goals; out of all nine are directly or indirectly related to the CE. The relevant goals are responsible consumption and production (SDG 12), climate action (SDG 13), life below water (SDG 14), life on land (SDG 15), affordable and clean energy (SDG 7), decent work and economic growth (SDG 8), industry, innovation and infrastructure (SDG 9); sustainable cities and communities (SDG 11); and partnership for the goals (SDG 17)^{1,2} (Azizuddin et al., 2021). Moreover, there are about 13 policy frameworks taken between 1995 to 2019, which played a role in the implementation of CE practice in Bangladesh (Fox et al., 2013).

As can be seen in Table 1, we divided eight sectors based on the availability of data and successive relevance. Firstly, comes the garments sector. The main foreign-earning sector of Bangladesh is the garments sector; it generates about 4.2 million jobs. About 5,000 garments existing generate a huge amount of waste, including 217 million m³ of wastewater (Alom, 2016). It is estimated that in the year 2021, about 2.91 million fabrics will be produced, which will generate about 349 million m³ of wastewater (Brett, 2018). It is estimated that if the leftover garments ‘jhut’ is reused and recycled, it can help this sector become a \$4 billion industry; moreover, the income would get double (Ovi, 2014). The present practice of collecting garments waste and companies like Filotex and Reverse Resources are helping to initiate circular practice in this sector (Team, 2018), and will eventually help to achieve SDG 8, SDG 9 and SDG 12 (Akter et al., 2022); by the creation of jobs, ensuring sustainable consumption and production practice after the garments sector comes tannery as a matter of priority, as it is the second-largest earner of foreign currency. In the tannery sector, there is no such direct CE practice; however, in the case of waste management, the government has built central effluent treatment plant (CETP) and sludge power generation system (SPGS), which have the potential to process the hazardous waste of tannery in an eco-friendly manner as well produce a renewable form of energy (Alamgir and Jalil, 2017; Schroeder et al., 2019). Moreover, a green supply chain initiative has been taken, which has the potential to help in sustainable industrialisation with sustainable production practices (Moktadir et al., 2018). Altogether, with the prospect of renewable energy production, using SPGS can help in achieving SDG 7, SDG 9 and SDG 12. In the case of paper production, Bangladesh has about 100 paper mills that produce 6–8 million tons of paper each year. After satisfying demand, Bangladesh exports paper to more than 30 nations. In Bangladesh, less than half of all used papers are recycled. According to a survey conducted in Dhaka, approximately 6,500 ‘Tokais’ (waste collectors) and 3,600 ‘feriwallas’ (Hawkers) collect used paper (Chakraborty and Aaqib Javed, 2018). The use of recycled fibre is mostly seen in privately owned paper mills; however, that use is not predominant (Quader, 2011). This waste collection practice and increased use of recycled fibre can transfer this

sector into an eco-friendly, sustainable one (SDG 12). This will also ensure less cutting down of trees due to a reduction in the use of virgin fibres (SDG 15).

According to waste concern, the per-capita usage of plastic in Bangladesh was 3.5 kg in 2014. Only 9.2% of all plastic use was recycled, suggesting that the remainder was ultimately thrown away and hurt the environment. If Dhaka's waste is gathered using contemporary technology, almost 75% of it may be recycled into new products, which would result in saving \$7 billion of foreign currency (Moazzem, 2016). Although Dhaka recycles 137.57 tons of plastic per day, the sad truth is that environmental and health concerns are not sufficiently addressed (Ministry of Environment & Forests of Bangladesh, 2010). If recycling practice is ensured in this sector, it can help in ensuring a sustainable consumption production pattern along with a sustainable, eco-friendly industry pattern (SDG 9 and SDG 12). Then, we discuss the main source of fuelling industrialisation, which is the energy sector. By building large-scale projects like solar power plants, the Bangladesh Government wants to use renewable energy for 10% of its total energy (Nabi, 2019). Aside from that, solar power is widely used by rural residents (Sharif et al., 2021). The solar home system (SHS) serves to alleviate poverty by providing income-generating activities; as of 2018, there were 5.8 billion installations. Biomass or biogas, as well as wind power, account for 1% and 0.5% of the total renewable energy production, respectively. Moreover, the Karnaphuli Hydroelectric Power Station, which generates 230 megawatts of power, is a renewable power plant that generates electricity from water (Mozumder, 2003). Near Bangladesh's Gazipur district, a private enterprise sponsored by the World Bank was producing power from biomass in Kapasia upazilla. Rice husk is employed in this biogas production. Three bags of rice husk can provide 30–40 KW of energy every hour. A furniture business in Gazipur, Bangladesh, utilises a biomass-fired boiler, which saves Tk. 52.5 lacs per year (Ministry of Environment & Forests of Bangladesh, 2010). In this sector, the generation of electricity from renewable sources reduces greenhouse gas emissions, which helps to keep the air clean and thereby slows climate change (SDG 11 and SDG 13). Moreover, renewable energy sectors can make strides toward building a long-term sustainable manufacturing strategy (SDG 9 and SDG 12). Next comes the agriculture sector, in the agriculture sector there is a significant practice of sustainable production practice using wastewater and compost fertiliser, and the compost fertiliser can be produced by using the agricultural wastes (SDG 12) (Roy et al., 2013).

The entire amount of e-waste generated in 2018 was 4 lakh tonnes; by 2045, the number is expected to be 46.2 lakh tonnes (Aowsaf, 2019). The e-waste recycling business makes a significant contribution to the economy. It has created several job opportunities. Everyday, around 15% of the total garbage generated in Dhaka City is recycled, amounting to 475 tonnes (Hossain et al., 2010). Bangladesh saved roughly US \$4.73 million in 2006 by extracting lead from used lead-acid batteries. At the moment, there is only one battery buyback company that is privately owned. One of Bangladesh's largest lead-acid battery producers was inspired by a government decision to support environmentally friendly production and build a smelting plant to recycle batteries sustainably. The facility has the capacity to recycle 660,000 batteries annually and recover 33,000 tons of hard lead (Ministry of Environment & Forests of Bangladesh, 2010). E-waste recycling will aid in the transition to a more sustainable method of production while also creating new jobs in the economy (SDG 8, SDG 9 and SDG 12).

Table 1 SDG implications towards CE practice in major sectors of Bangladesh

| <i>Industry</i> | <i>Current practices</i> | <i>Related SDGs</i> | <i>Comments</i> |
|-----------------|---|---------------------|--|
| Garments | <ul style="list-style-type: none"> Filotex Ltd. is Bangladesh's first company to engage with the circular fashion concept. A reverse resource is attempting to create a marketplace for garment waste. Simco Spinning and Textile manufactures yarns from discarded cotton clips. | SDG 8 | Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all. |
| | | SDG 9 | Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation. |
| | | SDG 12 | Ensure sustainable consumption and production patterns. |
| Tannery | <ul style="list-style-type: none"> Construction of central effluent treatment plant (CETP) and sludge power generation system (SPGS) in Savar, Bangladesh, to process hazardous wastes and generate electricity from them. Introduction of green supply chain. | SDG 7 | Ensure access to affordable, reliable, sustainable, and modern energy for all. |
| | | SDG 9 | Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation. |
| | | SDG 12 | Ensure sustainable consumption and production patterns. |
| | | | <ul style="list-style-type: none"> The implication of some recycling practices toward garments waste is helping directly to ensure some sort of sustainable consumption pattern (SDG 12). It will help indirectly to the creation of jobs, and sustainable economic growth through the use of recycling practices in building relatively sustainable industrialisation practices in the garments sector (SDG 8 and SDG 9). The processing of tannery waste to produce electricity helps in ensuring a production pathway for sustainable energy (SDG 7). The use of CETP helps in reducing the pollution of water bodies and helps to follow sustainable production patterns (SDG 12). Eco-friendly management of tannery waste helps in establishing sustainable industries (SDG 9). |
| Paper | <ul style="list-style-type: none"> Although private manufacturers combine a considerable part of recycled fibres with virgin fibres, the Karnaphuli paper mill in Bangladesh uses less than 10% or fewer recycled fibres in the overall supply. In Bangladesh, less than half of all used papers are recycled. Paper packets are manufactured by utilising used papers in addition to recycling. | SDG 12 | Ensure sustainable consumption and production patterns. |
| | | SDG 15 | Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. |
| | | | <ul style="list-style-type: none"> The recycling of paper will help to build a sustainable production pattern (SDG 12). There will be less cutting down of trees if recycled fibres are used prominently in the production process (SDG 15). |

Note: SDGs relevance with the current practices was determined by the authors, whereas the current practices were collected mainly from the study of Ahmed et al. (2022).

Table 1 SDG implications towards CE practice in major sectors of Bangladesh (continued)

| <i>Industry</i> | <i>Current practices</i> | <i>Related SDGs</i> | <i>Comments</i> | |
|-----------------|--|---------------------|--|---|
| Plastic | <ul style="list-style-type: none"> • Only 9.2% of Bangladesh's plastic garbage is recycled each year. • 137.57 tons of plastic are recycled per day in Dhaka, Bangladesh, yet health and environmental issues are not adequately addressed in recycling. | SDG 9 | Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation. | |
| | | SDG 12 | Ensure sustainable consumption and production patterns. | |
| Energy | <ul style="list-style-type: none"> • The largest solar power plant in Teknaf's Hnila is currently operational, producing 28 MW of power. • Solar-generated electricity is widely used, especially among rural people. • Biomass or biogas, as well as wind power, account for 1% and 0.5% of total renewable energy output in Bangladesh, respectively. • In Bangladesh's Gazipur Province, a private enterprise supported by the World Bank is using biomass to generate electricity. • The Kamaphuli Hydroelectric Power Station, which generates 230 megawatts of power, is a renewable power plant that generates electricity from water. • A furniture business in Gazipur, Bangladesh, employs a biomass-fuelled boiler, which saves Tk. 52.5 laes per year. | SDG 9 | Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation. | |
| | | SDG 11 | Make cities and human settlements inclusive, safe, resilient and sustainable. | |
| | | SDG 12 | Ensure sustainable consumption and production patterns. | |
| | | SDG 13 | Take urgent action to combat climate change and its impacts. | |
| | | | SDG 9 | Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation. |
| | | | SDG 11 and SDG 13). | <ul style="list-style-type: none"> • The power generation from renewable sources causes a reduction of greenhouse gas emissions, which helps to keep the air pure, thus helps in impeding climate change (SDG 11 and SDG 13). • The industries using the renewable mode of energy can move forward to establishing a sustainable production practices (SDG 9 and SDG 12). |

Note: SDGs relevance with the current practices was determined by the authors, whereas the current practices were collected mainly from the study of Ahmed et al. (2022).

Table 1 SDG implications towards CE practice in major sectors of Bangladesh (continued)

| <i>Industry</i> | <i>Current practices</i> | <i>Related SDGs</i> | <i>Comments</i> |
|-----------------|--|--------------------------|--|
| Agriculture | <ul style="list-style-type: none"> Wastewater used in irrigating land. Compost fertiliser is produced using agricultural wastes. | SDG 12 | <p>Ensure sustainable consumption and production patterns.</p> <ul style="list-style-type: none"> The production of compost fertiliser by the use of agricultural waste will help to ensure sustainable production practice. |
| E-waste sector | <ul style="list-style-type: none"> One of Bangladesh's leading lead-acid battery manufacturers has developed a smelting plant to recycle batteries in an environmentally responsible manner, with the goal of recycling 660,000 batteries, including reclaiming 33,000 tons of hard lead each year. Every day, around 15% of the total generated e-waste in Dhaka city is recycled, amounting to 475 tons. Bangladesh saved roughly US \$4.73 million in 2006 by extracting lead from used lead-acid batteries. Bangladesh's economy benefits from e-waste recycling since it creates job opportunities. | SDG 8 SDG 9 SDG 12 | <p>Promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all.</p> <p>Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.</p> <p>Ensure sustainable consumption and production patterns.</p> <ul style="list-style-type: none"> E-waste recycling will help to shift towards a sustainable mode of production, as well as adding new jobs to the economy. |
| Ship-breaking | <ul style="list-style-type: none"> Every year, almost 20 lakhs metric tonnes of outdated ships are recycled in various Bangladeshi yards. The majority of vessel elements, which are largely steel, are recyclable. This industry generates a lot of money in addition to providing job opportunities. | SDG 8 SDG 9 | <p>Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.</p> <p>Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.</p> <ul style="list-style-type: none"> The sustainable model of recycling and the creation of jobs will help the economy of the country to grow in an eco-friendly manner (SDG 8 and SDG 9). |

Note: SDGs relevance with the current practices was determined by the authors, whereas the current practices were collected mainly from the study of Ahmed et al. (2022).

Finally comes the ship-breaking industry, every year, almost 20 lakhs metric tonnes of outdated ships are recycled in various Bangladeshi yards. The majority of vessel elements, which are largely steel, are recyclable. This industry also generates a lot of money and provides job opportunities. According to the European Commission, 40% of Chittagong's coastline is utilised for ship-breaking (Hossain, 2017; Patwary, 2019; Sejan, 2019). The sustainable, eco-friendly practice of recycling will help to develop an eco-friendly production practice and will create job opportunities helping for sustainable economic growth and employment opportunities for the vast unemployed youth of Bangladesh (SDG 8 and SDG 9).

5 Setbacks of CE application and SDGs implementation

The Bangladeshi Government places a high focus on environmental conservation. The state must preserve and protect natural resources, biodiversity, wetlands, forests, and animals for current and future generations of Bangladeshi citizens, according to Article 18A of the country's constitution.

The Environment Conservation Act of 1995's Article 12 mandates that every industry obtain an environmental clearance certificate issued by the director general. The Environment Conservation Rule of 1997 further divided projects into four main categories for which the Environment Clearance Certificate can be awarded. The four categories are red, orange B, orange A and green.

Farmland in Bangladesh is being converted into a wasteland as a result of businesses breaching the law and harming the environment at an alarming rate (Yousuf, 2019). Even when compared to the appropriate allowed discharge limits, the concentrations of the majority of polluting parameters in the effluents are excessive (Azizul Haq, 1989). According to research, businesses contaminate the air and water by emitting smoke, managing solid waste poorly, and discharging untreated effluent into bodies of water like lakes, rivers and groundwater (Alam, 2009). Moreover, banks and other financial institutions are still lagging behind in providing green financing (Rashid and Uddin, 2018).

According to Moktadir et al. (2020), the construction of a CE model in Bangladesh is hampered by a lack of financial resources. According to Dulia et al. (2021), the biggest concern connected to CE procedures is the deterioration of recycled items' quality.

Regarding the challenges of applying CE and related SDGs in Bangladesh, the researchers interviewed some experts and young activists from Bangladesh. They are the president of SDG Youth Forum Bangladesh (KII-1), the coordinator of Youth Platform for Sustainable Development -YPSD (KII-2) and a young researcher in governance and public policy (KII-3) from Bangladesh. Their comments have been summarised as follows:

- 1 Governance problem: There are many administrative lacking in Bangladesh that prevents applying both the CE model and achieving SDGs directly related to environmental sustainability. The KII-1 and KII-3 express this opinion.
- 2 Policy bottleneck: As per the KII-2, Bangladesh has been suffering from a lack of appropriate policies to uphold environmental sustainability and practice a CE approach.

- 3 Public perception barriers: Both KII-1 and KII-2 agreed that, to promote environmental sustainability and achieve the SDGs, public awareness is very critical. However, in Bangladesh, even educated people are not aware of environmental protection and pollution control.
- 4 Political impediments: Bangladesh also faces lots of political barriers that prevent environmental improvement. Major industries polluting air and water are owned by political elites, who are also part of the country's power structure. KII-1 and KII-3 focused on this issue.
- 5 Capability drawbacks: Both technological and institutional capacity is important to achieve SDGs and applying the CE model in any country. Bangladesh has been suffering from the lack of these two capabilities. KII-2 and KII-3 mentioned this issue during the conversation with them.

6 Discussion and conclusions

There has been an increasing trend of research involving sustainable development and CE from the year 2019, indicating a positive aura in the research field regarding the importance of CE and SDGs in Bangladesh. Though among the CE practices in Bangladesh, recycling is mostly followed (Ahmed et al., 2022), there is seen a disparity in the recycling rate. The key problem lies in domestic and industrial waste disposal. The waste collection efficiency in Bangladesh lies between 44.30% to 76.47%; to reach a sustainable development plethora, it is necessary to raise the efficiency level to 100% (Azizuddin et al., 2021).

The practice of CE can help to achieve SDGs as they are interrelated. It is found that the CE model is limited to recycling practices in certain industries; however, it helps to achieve some of the key SDGs. Out of our study eight sectors, the relevance of SDG 9 was the maximum coming about six of the times, in garments, tannery, plastic, energy, e-waste and ship-breaking sector. Then comes SDG 12, which was relevant to garments, tannery, paper, plastic, energy and agriculture. Moreover, SDG 8 was found to be relevant in two of the sectors, which are garments and ship-breaking. Finally, other SDGs, 11, 13 and 15, are relevant to one of the sectors each. SDGs 11 and 13 relate to only energy, and SDG 15 is relevant to the paper sector.

The relevance does not mean these sectors are properly playing a role in fulfilling those goals; however, it means that the existing practice, limited to only recycling for most cases, helps to achieve these goals to a certain extent, however, to make these sectors sustainable enough the government and stakeholder have to play a role in properly implementing CE practices.

The proper implementation of the practice of CE is opposed by some major challenges existing in Bangladesh. The most important is the mismatch between CE practice implementation and government policies. Moreover, there are lack of logistic support, a lack of use of innovative and efficient technology use, a lack of proper drainage systems, plastic clogs, and serious water, air, and soil pollution due to the disposal of industry and urban waste in the environment (Azizuddin et al., 2021). Furthermore, it is found that there is a lack of awareness among the citizens of Bangladesh, including the educated ones, regarding environmental protection and pollution control.

In this scenario, the government needs to promote a sustainable approach (Johnston, 2017). The partnership of government with private stakeholders is necessary, along with the modernisation of the government system and the enactment of updated effective laws (Azizuddin et al., 2021). Not just the enactment of laws but enactment and fair implementation of the law is necessary (Azizuddin et al., 2021). Overall, we need a comprehensive approach fuelled by a green agenda and a long-term sustainable development plan.

As this research is a first attempt to understand the nexus of CE with SDGs comprehensively by introducing a bibliometric analysis, review of literature, and interview of experts, it hopes to benefit policymakers, development practitioners, and relevant stakeholders of Bangladesh.

This study poses some limitations, as the information on Bangladeshi Government policies on CE and SDGs was challenging to come by. Furthermore, there were no funds available to carry out this research. Despite these limits, the authors worked hard to make this work as good as it could be. The authors hope to see more research on the individual performance of industry to achieve SDGs, more empirical primary data-based analysis would be expected.

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Notes

- 1 See https://www.sdg.gov.bd/page/thirty_nine_plus_one_indicator/5#1
- 2 See <https://www.undp.org/sustainable-development-goals>