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ECO-FRIENDLY BIO-MEDICAL WASTE MANAGEMENT TECHNOLOGY PRACTICE IN BANGLADESH FOR SUSTAINABLE DEVELOPMENT

***Mohammed Ali Arshad Chowdhury[1] & Md. Zahedul Islam[2]**
***Corresponding Author**
[1]Department of Accounting, University of Chittagong, Chattogram-4331, Bangladesh,
[2]Department of Accounting, University of Chittagong, Chattogram-4331, Bangladesh

*arshad@cu.ac.bd, zahedul.islam@cu.ac.bd
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ABSTRACT

Currently Sustainable Development Goals (17 goals) are the main challenges for industrialization and infrastructure development for an economy. One challenge faced is in developing economy like Bangladesh where the focus of industrialization has been given priority by sacrificing natural conservation. Recently a large number of health cares have been established all over the country. Therefore, a huge amount of medical wastage is generated daily and Bio-medical waste management is inevitable for sustainable development. The management of bio medical waste is directly relevant to SDG goal 3 (Good health and well- being), 6 (Clean water and sanitation), 11(Sustainable cities and communities), 13(Climate action) and 15(Life on land). From the literature, it has been found that few eco-friendly waste management technologies are available and adopted by various countries. This paper aims to identify the bio-medical waste management practice in Bangladesh and whether it is eco-friendly or not. A survey was conduced to 176 respondents from 22 healthcare institutions; the study showed that most of the health care institutions transfer their medical wastage to the responsible municipality/local authority. In addition, opinions of the responsible environmental managers concern health care institutions confirmed the lack in capacity of executing eco-friendly bio-

medical waste management technologies in Bangladesh. By using the result of this study, it is hoped healthcare institutions of developing countries like Bangladesh can apply eco-friendly waste management technology for ensuring sustainable development.

Keywords: *SDG, Bio-medical Waste Management, Eco-friendly Waste Management Technology, Bangladesh*

INTRODUCTION

Currently, Sustainable Development (SD) has become the buzzword in the business world. Literally, Dernbach (2003) and Stoddart (2011) connote Sustainable Development as development that can be continued for the given time period. The often cited SD definition from Brundtland Commission Report (Schaefer & Crane, 2005) as development that fulfills the needs of the current generation without compromising the ability of future successions to meet their own demands. Therefore, sustainable development concept calls for improving living standards without endangering the earth's ecosystems or causing environmental challenges such as deforestation and water and air pollution that can result in problems such as climate change and extinction of species (Browning & Rigolon, 2019). Moreover, the essence of SD is internationally recognized from the beginning of 1970's and has continued till to date. For instance, UN Conference on the Human Environment, Stockholm (1972); Rio Earth Summit (1992); World Summit on Sustainable Development (2002); Rio Earth Summit (2012); UN SDGs, 2017 etc. (Mensah, 2019).

According to Taylor (2016), SD consists of three main pillars such as economic sustainability, social sustainability, and environmental sustainability. Among these, the concept of environmental sustainability is about the natural environment and how it remains productive and resilient to support human life. It relates to ecosystem integrity and carries capacity of natural environment (Brodhag & Talière, 2006). Thus, environmental sustainability is urgent for reducing climate change effect which leads to the SDG achievement (17 goals).

One of the top issues of Environmental sustainability is effective waste management of an entity (Zhang et al., 2022). It is more important when an entity deals with infectious waste especially medical or health care organization (Singh, Ogunseitan, & Tang, 2022). The effective waste management of health cares is closely related to the SDG goal 3 (Good health and well- being), 6 (Clean water and sanitation), 11 (Sustainable cities and communities), 13 (Climate action) and 15 (Life on land). Employees of healthcare and citizens of a city are in great danger of mismanagement of bio-medical wastes as good health is essential for sustainable development and it is included in 2030 agenda of United Nations according to SDG 3. About three billion people have been suffering from hand washing facilities and two in five health care facilities have no soap or water. Hand washing facilities is essential in every stages of waste management (generation, segregation, treatment, and disposal) to reduce the risk of infections. One of the main targets of SDG 11 is to reduce the environmental effect of cities. Proper treatment of bio-medical wastages is vital for a clean and safe city (Organization, 2020). An important goal of SDG 13 is to strengthen resilience and adaptive capacity to climate-related disasters and integrate climate change measures into policies and planning. Protecting bio-diversity and natural habitats is the main target of SDG 15 (UNDP, 2022; Wikipedia, 2022b). It is impossible to diminish the impact of bio-medical waste without proper management and SDG achievement without policy implementation.

In Bangladesh, there are around 5,709 hospitals with 141,903 beds in total, along with an additional 9,061 diagnostic Centre beds generating huge amounts of medical waste (Md Mostafizur Rahman, Bodrud-Doza, Shammi, Islam , & Khan, 2021). As a densely populated country, most of the people are unaware about the use of medical kits (Banik, Rahman, Sikder, & Gozal, 2020). For instance, Tongi police station (East) convicted a man on charges of recycling used masks and hand gloves that the hospitals in Tongi, Uttara and Gazipur had thrown away as waste (Alo, 2020). Therefore, poorly managed medical waste poses a large environmental threat and may create a prolonged and unwanted public health hazard and could be the potential source of re-emerging infection.

Against the backdrop, this paper attempts to know the status of the current practice of eco-friendly bio-medical waste management technology in the healthcare sector of Bangladesh and to know whether the hospital

authority uses the best alternative of bio-medical waste management technology. In this regard, this study measures the capacity of bio-medical waste management at organization level (policy-making and organization's capacity) and implementation level (employee capacity).

BACKGROUND OF THE STUDY

A review paper on sustainability by Mensah (2019) proposed the relationship among the three factors such as economic sustainability, social sustainability and environmental sustainability. Mere emphasis on economic sustainability had a negative impact on nature (Hardisty, 2010). Social sustainability in terms of quality of life and community development has come to the light. Finally, environmental sustainability is recognized by all concerns in the recent world. Interestingly, recent studies revealed the consideration of environmental sustainability issues for an entity that poses positive economic sustainability of the organization.

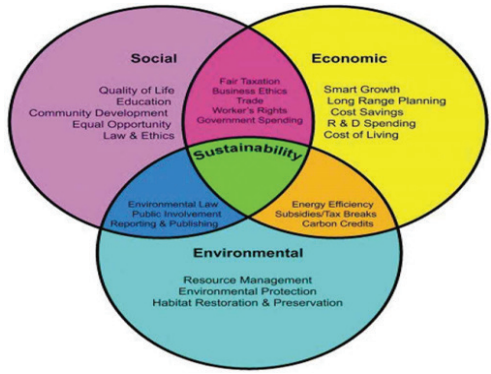


Figure 1. Sustainable Development Concepts
Source: Justice Mensah, (2019)

For example, various stakeholders such as politicians (Gore, 1992), chief executive officers of major chemical companies (Reilly, 1990), and prominent scholars (Dowell, Hart, & Yeung, 2000; Farrow, Goldburg, & Small, 2000; Stead, McKinney, & Stead, 1998; Zhu & Sarkis, 2007) argued that improving environmental practices do not necessarily lessen a firm's financial performance. Moreover, Clemens (2001) has claimed that environmental performance could provide a competitive advantage.

However, many researchers argue that environmental safety actions lead several economic benefits to the companies like cost savings and increased efficiency, quality enhancements, improved corporate image and community relations, reduced responsibilities, access to new markets (González-Benito & González-Benito, 2005, 2006, 2008; Porter & van der Linde, 1995; Shrivastava, 1995).

Against these views, the adaptation of eco-friendly strategies and technologies by healthcare institutions is not merely reducing the negative impact on the earth; it fulfills the economic and social sustainability as well. Thus, this study examines to know the current status of eco-friendly waste management technologies for achieving the sustainable development.

OBJECTIVES OF THE STUDY

The main aim of the study is to know the current status of eco-friendly bio-medical waste management technology practices for the sustainable development of Bangladesh. To achieve the goal, the following secondary objectives are to be examined.

a. To identify the existing practice of bio-medical waste management technology in hospitals
b. To determine the capacity and challenges of the eco-friendly bio-medical waste management technology among the hospitals
c. To determine the knowledge on bio-medical waste management technology practices and the SDGs among the hospital employees

RATIONALE OF THE STUDY

Bangladesh is a densely populated country in the world. The density of the population of cities is more than its overall density. Population growth is significantly correlated with the environmental pollution (Mohammad Mafizur Rahman & Alam, 2021). As a developing country, the number of public health institutions in city are inadequate. In order to meet the health services, a huge number of hospitals, clinics, diagnostic centers are allowed by the government. Despite having the health service providers of the country, they are generating vast risky waste which may bring threat to the nature and species (A. Rahman, Talukder, & Karim, 2022). As a result,

the Bangladeshi government has introduced Bangladesh Medical Waste Management Rules effective since 2008. Therefore, it is essential to identify the effectiveness of technology used by the health institutions to control the bio-medical waste. In addition to that, is to determine the knowledge of waste management employees regarding bio-medical waste management and the challenges to implement the right technology. On the contrary, a few research have been conducted on the practice of Bio-medical Waste Management focusing (Basak, Mita, Ekra, & Alam, 2019; Reza & Akter, 2018; Som & Hossain, 2018) on the quantification of waste generation, waste separation, waste transportation and waste disposal. In fact, there is no research yet to conduct to judge the effective technology of Bio-medical Waste Management. Nevertheless a few research showed the capability of Bio-medical Waste Management of the hospital in terms of attitude, knowledge of the employees and practice of Bio-medical Waste Management conducted in many countries such as India (Gupta, Shukla, & Tyagi, 2016), Iran (Alimohammadi et al., 2018), Nigeria (Anozie et al., 2017), Ethiopia (Deress, Hassen, Adane, & Tsegaye, 2018), etc. Since Bangladesh has a different corporate and socio-economic culture and targeted to be in the middle level income country by 2027 and SDGs achievement by 2041, the practice of Bio-medical Waste Management technology and knowledge level of implementation workers should be explored. Moreover, the outcomes of the current study will provide a new dimension to the policymaker and Health institutions managers to use the right technology and knowledge improvement in using the proper technology efficiently.

LITERATURE REVIEW

Bio-medical waste management has become an emerging issue because of environmental safety (Kannadhasan & Nagarajan, 2022). We found the significance of the Bio-medical Waste Management practices from earlier research such as in Korea (Jang, Lee, Yoon, & Kim, 2006), Croatia (Marinković, Vitale, Holcer, Džakula, & Pavić, 2008), Turkey (Birpınar, Bilgili, & Erdoğan, 2009), Jordan (Abdulla, Abu Qdais, & Rabi, 2008), Myanmar (Aung, Luan, & Xu, 2019), Nigeria (Awodele, Adewoye, & Oparah, 2016), China (Gao et al., 2018), Cameroon (Dzekashu, Akoachere, & Mbacham, 2017), Greece (Zamparas et al., 2019) etc. These papers discussed about the Bio-medical waste generation, composition, segregation,

transportation, and disposal of bio-medical wastes. In addition, earlier studies have identified the incineration and landfilling as the most used technology of Bio-medical wastes. A summary of different Bio-medical Waste Management Technology, its advantages, disadvantages with the cost and knowledge required by the employees is presented in Appendix-2.

On the contrary, researchers have emphasized on the knowledge of the relevant employees as well as challenges of implanting a technology. Mathur, Dwivedi, Hassan, and Misra (2011) and Anand, Jain, and Dhyani (2016) found that doctors, nurses, and laboratory technicians have better knowledge than sanitary cleaners on bio-medical waste management. According to Deress, et al., (2018), the level of knowledge, attitude, and practice scores were not satisfactory in Ethiopia because a majority of the healthcare professionals did not participate bio-medical waste management training regularly to upgrade their expertist. In Egypt, despite the presence of legislation for hospital waste management, disposal of Bio-medical Waste has not been implemented by healthcare workers (Hakim, Mohsen, & Bakr, 2014) due to lack of knowledge. A study by Chudasama et al. (2013) based in Rajkot, India found that only 44.3% of study respondents participated in training program for Bio-medical Waste Management that expressed a lower intention towards waste management. Gupta et al. (2016) revealed that lack of knowledge and awareness about Bio-medical Waste Management amongst primary healthcare workers results in inadequate handling and managing, thereby exposing them to the general public on health and environmental hazards.

From an Iranian perspective, a study by Alimohammadi et al. (2018) showed that the relationship between attitude and practices was statistically significant. Also, this research found that the relationship between the individuals' work experience with the knowledge, attitudes, and practices of Bio-medical Waste Management were significant respectively. Dehghani and Rahmatinia (2018) explored no significant difference between male and female healthcare personnel among knowledge, attitude and practices of Bio-medical Waste Management. The study of Al Balushi et al. (2018) found satisfactory scores of knowledge, attitudes, and practice among nurse of Oman as compared to other participants like doctors, lab technician, etc. Therefore, it is evident that knowledge of employees especially who are directly involved with the Waste Management, about Bio-medical Waste and its management is a significant factor.

On the other hand, many researchers revealed the interdependence between Waste Management and Sustainable Development. For example, Agnieszka Ulfik (2014) highlighted on solid waste management for Sustainable Development, while Kanagaraj, Senthilvelan, Panda, and Kavitha (2015) addressed Eco-friendly Waste Management strategies for Sustainable Development after they reviewed the waste management of the leather industry in India. Moreover, Waste management for sustainable development has become a focused area recently as it is mentioned in the United Nations Sustainable Development Goals (Nazry, 2021). For instance, Fuldauer, Ives, Adshead, Thacker, and Hall (2019) highlighted a strategic planning of waste management for small island developing states in order to achieve the United Nation's sustainable development goals, Ladychenko, Melnychuk, Golovko, and Burmak (2020) studied the waste management at the local level of EU and Ukraine addressing SDGs.

Despite having these global research findings, very few research have conducted on bio-medical waste management and capacity among healthcare personnel in Bangladesh. Based on a survey of 7 hospitals of Dhaka a study by M. A. B. Sarker et al. (2014) showed that one-third of doctors and two-third of nurses had insufficient knowledge about medical waste to manage. In addition, inadequate nurses deteriorate the quality of health services in Bangladesh (Bala et al., 2021). Bhattacharjee and Saha (2015) found that insufficient knowledge among the health care personnel that excludes the doctors in a survey conducted at a hospital of Gazipur, Dhaka. A study by M. F. R. Sarker et al. (2020) discovered that the knowledge of waste management among the majority of healthcare personnel is still at infant stage though the study covered a 250-bed hospital of Jamalpur, Bangladesh only. Another paper by Behnam et al. (2020) addressed the knowledge, attitude and practice of waste management of hospitals in Chattogram. The finding of the study also indicates the inadequacy of knowledge of health workers considering 4 (four) hospitals that only focussed on a comparison of waste management between public and private hospitals and lab test results of discharged water quality. These papers did not measure the knowledge of waste management of health institutions on specific Bio-medical Waste Management Technology.

Thus, the current study attempts to measure the present status of Bio-medical Waste Management practice, knowledge about Bio-medical Waste

Management Technology of the employees and explain the relationship among the practice, knowledge and sustainable development.

METHODOLOGY

This study is a survey-based empirical research. The main goal of the study is to know the present condition of eco-friendly bio-medical waste management technology practices for the sustainable development of Bangladesh. In addition to that, the study measures the knowledge level of the hospital employees about the bio-medical waste management and the challenges of implementing eco-friendly waste management technologies. The following methods are followed to achieve the objectives of the study.

Population and Sample

All the public and private hospitals in Bangladesh and their employees are the population of the study. However, the ownership and services among the hospital in Bangladesh are almost similar in every division. Among the eight divisions, Chattogram is the largest in size and is the commercial capital of the country. Consequently, this study has considered all the large size (based on the facilities ensured suppose beds, no. of staffs, etc.) public and private hospitals of Chattogram City Corporation. Moreover, Chattogram City Corporation is also famous for its activities among the other authorities. The number of different types of hospitals in Chattogram City Corporation has been presented in the Table 1 below.

Table 1. Number of Healthcare Institutions in Chattogram

Public Medical College Hospital	01
Private Medical College Hospital	10
Chattogram City Corporation Controlled Hospital	06
Private Clinic	64
Diagnostic Center	116
Total	197

Source: Ministry of Health and Family Welfare Website, Chattogram City Corporation Website, BPCDOA (Bangladesh Private Clinic Diagnostic Owners Association), Wikipedia, Google

From the above categories of institutions, the study has considered only 22 which represents 11.17% of the total population. The low representation of the sample happened because of a small size of samples taken from the diagnostic centers. In fact, the services of the diagnostic centers are very limited and similar fashion engaging a few waste management employees. Thus, we left more than 20 diagnostic centers from our investigation. On the other hand, most of the public and private medical colleges have their own diagnostic facilities.

Table 2. List of the Sample Hospitals

Nature of the hospital	No of Sample	Percentage (%)
Public Medical College Hospital	01	100
Private Medical College Hospital	02	20
Chattogram City Corporation Controlled Hospital (local govt.)	02	33.33
Private Clinic	13	20.31
Diagnostic Center	04	3.45
Total	22	11.17

Source: Ministry of Health, Bangladesh

Apart from this, the study investigated the knowledge level of the employees and the workers about eco-friendly waste management and the SDGs. The number of surveyed employees and workers is pictured below.

Table 3. Number of Respondents (Waste management related employees and workers)

Particulars	Total employee	Number of respondents	Percentage (%)
Doctors	22	22	100
Administrators	22	22	100
Nurses	220	44	20
Cleaners	300	44	14.67
Sweepers	300	44	14.67
Total	864	176	20.37

Source: Data analysis

Though a large number of employees and workers are engaged with bio-medical waste management, most of the nurses, cleaners and sweepers were not interested to participate in the survey. As the job natures of these groups are the same, the minimum inclusion of respondents is sufficient to

get a fair representation of the population.

Questionnaire

There are two parts to this investigation. The first part is to know the current status of bio-medical waste management practices of the hospitals (see Appendix-1 on the types of waste management techniques). In the second part, the study identify the knowledge of the healthcare personnel and challenges of the implementation of relevant bio-medical waste management technology. In order to get the information, we divided the questionnaires into two parts – part-A includes current practices, and part-B measures the knowledge level and implementation challenges. The questionnaire was developed under the supervision of experts in the relevant field and based on previous literature. According to Awang and Mohammad (2015), the study assessed the content validity of the questionnaire by circulating five copies of questionnaire to the relevant expert and researchers. The questionnaire was circulated among the respondents based on the result of a pilot survey and after making the necessary amendment to it.

Data Collection

This study had also included an interview method for collecting data because most of the respondents are the 3rd or 4th class employees of the hospital. Most of them do not have an email or adequate knowledge to respond quickly. Besides, it is easy and time-saving for collecting data on a single day with the permission of the administration of the respective hospital. Maximum workers confessed their illiteracy and ignorance about eco-friendly waste management and SDGs though the administrators (most of them are doctors) have vast knowledge about these issues.

Data Presentation

After collecting and editing data, all the results are put in table. As per the opinions of administrators and workers, existing practice and capacity to adapt to the new one and limitations of workers' knowledge about eco-friendly bio-medical waste management and SDGs are discussed elaborately in the following section. Finally, a framework for future eco-friendly bio-medical waste management system is recommended

FINDINGS AND ANALYSIS

Maximum workers confessed their illiteracy and ignorance about eco-friendly waste management and SDGs, although the administrators (most of them are doctors) have vast knowledge about these issues.

Objective No.1

We found the existing practices of bio-medical waste management technologies (BMWT) for Research Objective 1. A list of BMWT used in healthcare institutions in different countries is attached in Appendix-1. A detailed of each BMWT evaluated with remarks is also attached in Appendix-2. The current practices of BMWT in Bangladeshi hospitals is presented in Table 4.

Table 4. Practices of Waste Management Methods of Hospitals in Bangladesh

Name of the methods	No. of Hospitals	% of Hospitals
Dumping	22	100%
Incineration	13	59.09%
Autoclaving	0	0
Microwave irradiation	0	0
Chemicals	0	0
Solar disinfection	0	0
Pyrolytic combustion	0	0
Landfill	0	0
Recycling-reuse	0	0
Plasma Pyrolysis	0	0

Source: Data Analysis

It is evident from the Table 4 that all the 22 hospitals that are situated in the Chattogram Metropolitan area used only two techniques for disposing of their medical wastes. The average scores revealed that 100 percent of the hospitals followed the dumping method for disposal purpose. Final disposal of bio-medical wastes is incinerated or land filled by Chattogram City Corporation are directly appointed by hospitals or third party. It is noticeable that 59.09% hospitals among the visited hospitals used incineration method. It is an indication of advancement towards a widely used technology in the

world 'incineration' for disposing of most hazardous wastes generated at hospitals. The respondents reported that the hospitals segregate the wastes at their origin and employ a third-party for incineration. We have also found that hospitals do have a good reputation in the Metropolitan area for their services followed both the dumping and incineration method for disposal of bio-medical waste. However, it is also found that hospitals of Chattogram Metropolitan area do not use the remaining eight methods for management of bio-medical waste, which are widely used in the modern world for the features of the more environment friendly and pollution preventive.

Objective No.2

We have also determined the capacity and challenges of implementing relevant BMWT.

Table 5. Opinions of Waste Management Managers about the Implementing Capacity of Methods

Methods	Replies	I	AR	CE	HHF	LET	RFS
D	Yes	72.73%	36.36%	72.73%	54.55%	50%	31.82%
I	Yes	81.82%	31.82%	31.82%	50%	81.82%	63.64%
A	Yes	72.73%	18.18%	18.18%	54.55%	81.82%	81.82%
MI	Yes	45.45%	50%	50%	50%	77.27%	45.45%
C	Yes	18.18%	18.18%	18.18%	18.18%	18.18%	18.18%
SD	Yes	31.82%	31.82%	31.82%	31.82%	31.82%	31.82%
L	Yes	22.73%	22.73%	22.73%	22.73%	22.73%	22.73%
PP	Yes	0%	0%	0%	0%	0%	0%
GS	Yes	31.82%	0%	22.73%	0%	22.73%	22.73%
TI	Yes	9.09%	9.09%	9.09%	9.09%	9.09%	9.09%

Source: Data Analysis I=Idea, AR=Available Resources, CE=Cost Effectiveness, HHF=Health Hazard Free, LET=Less Environmental Threat, RFS=Risk free for species.

The result of Table 5 shows that most of the respondents are familiar with waste management techniques named dumping (D), incineration (I), and autoclaving (A) but having poor knowledge about microwave irradiation (MI), solar disinfection (SD), gas sterilization (GS), landfill (L), chemicals (C), and thermal inactivation (TI) and they do not have any idea about plasma pyrolysis/pyrolytic combustion (PP). Based on the result, all the hospitals use dumping method but about 50% policy makers of the hospitals opined that the method is risky for environment and hazardous for health. More

interestingly, they claimed that they have limited resources to employ the method, although it is cost effective. The respondents informed that the other two methods- incineration and autoclaving which are known to the decision-makers of the hospitals are highly risky for environment and other species. Since the knowledge about the remaining methods is very limited, the replies about the other information on environment sensitiveness and implementation are insignificant.

Objective No.3

We have measured the knowledge on bio-medical waste management technology practices and the SDGs among the hospital employees.

Table 6 Opinions of Waste Management Employees and Workers about BMW and SDG

	Doctors	Administrators	Nurse	Cleaners	Sweepers
Does your company maintain a waste management policy?	100%	100%	40%	2%	2%
Do you know about the SDG?	100	70	7	0	0
Do you find any relationship between waste management policy and SDG?	77	32	0	0	0
Do you think waste management reduce the health risk?	100	100	94	87	76
Do you think waste management reduce the global warming?	88	93	3	0	0
Do you think BMW reduce the carbon emissions?	87	90	2	0	0
Do you think BMW relevant to clean water?	95	91	72	76	71
Do you think BMW relevant to sanitation?	92	94	93	99	93
Do you think BMW improve the water and sanitation?	100	100	94	94	93
Do you think BMW improve living standard of city dwellers?	100	100	48	65	67
Do you think BMW build the clean city?	100	100	79	82	89
Do you think BMW save the biodiversity and natural habitats?	97	100	6	0	0
Do you think BMW save the environment?	100	100	84	46	52

Source: Data Analysis

In this study, we surveyed five respondent groups that are directly related to the generation and management of bio-medical wastes. The results showed that most of the nurses, cleaners, and sweepers have a piece of poor knowledge about the waste management policy of their respective workplaces. Though the employees and workers are directly related to the origin and management of BMW, they have poor knowledge about its hazardous impact on the environment. Specifically, they are ignorant about the global warming, biodiversity and carbon effect. However, these groups showed positive opinions on clean water, sanitation, clean city, living standard, and environment.

On the other hand, doctors and administrators are highly positive about the relationship between BMW and SDGs individually. Surprisingly, they are traditional in case of waste management policy and SDGs. This is because corporate waste management policy does not provide and consider SDGs in their practice rather just to comply the government's regulations. For this, all the doctors and administrators replied positively. However, for Table 5, it was found that they do not have enough knowledge on world-wide used eco-friendly waste management technology. The other reasons of poor knowledge of eco-friendly bio-medical waste management are flexible government supervision, insufficient training, unskilled workers, unconscious public etc.

DISCUSSION

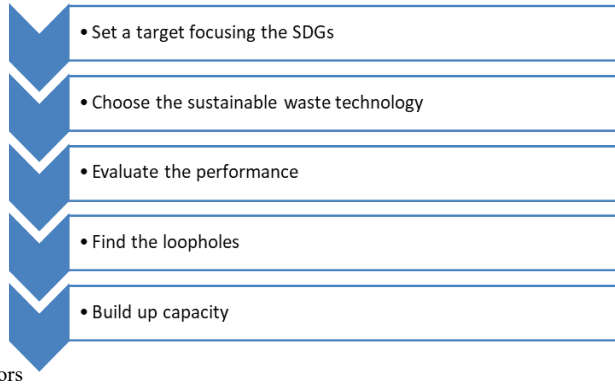
Based on findings, doctors and managers are familiar with the BMWT and SDGs very well but not interested to adopt policy as they lack in experts in implanting stages. On the other hand, workers and employees are ignorant about the bad impact of BMW resulting in poor Bio-medical waste management. Authorities are reluctant to improve the situation since there is weak support from the corporate governance and absence of stakeholders' pressures. In spite of having Bio-medical Waste Control Rules, poor supervision and weakness of law enforcement agencies are mainly responsible for the current status (Shammi et al., 2022). The other stakeholders such as NGOs, Financial Institutions, Media, Competitors, Citizens and Society are also very reluctant to highlight the negatives sides of mismanagement of Bio-medical Waste (A. Rahman et al., 2022). This

may happen because of a slow environmental degradation and impact to human and other species. That is why it is essential to educate the workers related to the Bio-medical Waste dealings in order to prevent the long term loss. Moreover, all the trainings, seminar, conferences, workshops relating to environmental sustainability and sustainable development are confined only to the top level management for example doctors and owners of hospitals.

Top level management is required to upgrade their knowledge and they should do the same in educating their workers on this. If this was not addressed properly, the knowledge gap about the Bio-medical Waste Management and Sustainable Development between top level management and workers at implementation stage will increase. This requires a balance in knowledge development between workers and doctors by arranging different learning programmes. The existing practice of disposing waste is unscientific because the City Corporation workers who are actually managing the household waste dispose. Since the nature of the household waste and Bio-medical Waste is different, thus either City Corporation cleaners should have proper knowledge of dealing Bio-medical Waste or health institutions will have to separate Bio-medical Waste management technology. According to the planned behavior theory (Heidari et al., 2018), health institutions should put emphasis on environmentally friendly intended employees at appointment level. It will be easy to teach and improve the workers learning and knowledge level if government and the healthcare institutions initiate'd different educational programmes like workshops, training etc to the employees.

PROPOSED FRAMEWORK:

According to the objective no. 1, a hospital can use an eco-friendly waste technology to save the humanity and the earth.



Source: Authors

Apart from this framework, both the government and hospital can work together to enhance knowledge (refer to Objective no.2) and overcome challenges (refer to objective no.3) in targeting the SDGs by introducing eco-friendly waste technology. The suggestions are attached with the following table.

Integrated Goal (govt./ hospital)	Integrated Objectives (govt./hospital)	Responsibilities (government)	Responsibilities (hospitals)
SDGs -Clean city -Reduce Global warming -Reduce carbon emission -Clean water -Sanitation -Bio-diversity and natural habitats	-waste segregation -identify risky/sensitive waste -reduce waste at source -in-house treatment/ combined treatment for similar types of wastes -separate by product material	-Inclusive waste management policy (capacity of hospitals) -Include eco-friendly waste management subject in medical education -Offer BMW diploma for hospital workers -Categorize hospitals as per waste generation (chemical/ liquid/solid/risky) -Suggest eco-friendly waste management technology for different waste generated hospitals -Arrange training for workers continuously	-Inclusive training for all employees and workers -Segregate waste at source as per risk and by product materials -Separate waste management wing -Backward linkage subsidiary for reuse of waste (For example, all the plastic tubes can be recycled)

Source: Authors

CONCLUSION

Nowaday, Sustainable Development (SD) and Sustainable Development Goals (SDGs) recommended by the United Nations have received much attention from researchers. In addition, the recent pandemic that occurs has influenced the prominence of the sustainability issue (Lakner, Plasek, Kiss, Soós, & Temesi, 2021). Any kinds of waste are contaminated if it is not treated properly. Bio-medical waste is more vulnerable than any other wastes due to its high sensitivity. Improper management of bio-medical waste can hamper Sustainable Development Goals (SDGs) in many ways (Nabavi-Pelesaraei, Mohammadkashi, Naderloo, Abbasi, & Chau, 2022). On the contrary, hospitals, diagnostic centers, clinics, healthcare have been boosted in the city to meet the demand of city dwellers. As a densely populated country, Bangladesh has allowed all establishments like residential, shopping malls, playground, entertainment parks and hospitals in the same area. Therefore, managing bio-medical waste has become a crucial health issue for the hospital workers and the general public and environmental perspective. As per literatures, it is evident that developed and developing countries like Malaysia (Keshminder, 2018) in the world have applied eco-friendly waste management technologies. Besides, Bangladesh is an active partner in reducing global warming and climate change impact and has already achieved MDGs and concerned about SDGs (Ashraf, Ullah, Shuvro, & Salma, 2019; Nasrullah, 2021). Hence, this paper examines the practice of bio-medical waste management technology in hospitals and investigates the knowledge about eco-friendly waste management systems and SDGs relevant to BMW. The results revealed that dumping is a common practice for managing bio-medical waste in Bangladesh where incineration is used in some particular cases. Past research and current work on SDG have suggested that this system is highly responsible for spreading diseases and the environment. Also, the people (nurses, sweepers, and cleaners) involved with the bio-medical waste management have inadequate knowledge of eco-friendly waste management. This is in contrast with the top management, such as the doctors and administrators who responded positively about their limited command of all sorts of eco-friendly waste technologies. They have also confessed the limitations of available resources if alteration occurs. In this circumstance, this paper proposes a framework for eco-friendly waste technology. However, this paper considered only one region of the country and collect feedback from the administrator and the worker (2 of

each category for every sample) of 22 hospitals. The result may be different if the investigation considers the entire population in the country or the capital city Dhaka. Further research on effectiveness of BMWM rules 2008 is encouraged to gain a better understanding of the issue.

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AUTHOR CONTRIBUTIONS

The distribution of the work is shown below: Conceptualization, M.A.A.C. and M.Z.I.; methodology, M.A.A.C. and M.Z.I.; data collection, M.Z.I.; formal analysis, M.A.A.C.; investigation, M.A.A.C.;resources, M.A.A.C. and M.Z.I.; data curation, M.Z.I.; writing—original draft preparation, M.A.A.C. and M.Z.I.; writing—review and editing, M.A.A.C.; supervision, M.A.A.C.; project administration, M.A.A.C.; Both authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

Both the authors declare that, they have no conflicts of interest.

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Sekian, terima kasih.

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