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REVIEW

# A review of the applicability of Environmental Management Systems in waste management in the medical sector of Zimbabwe

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**Abstract** Environmental Management Systems (EMS) are currently the cornerstone of achieving sustainability globally. Nevertheless, the question is applicability of EMS in the medical sector. Hence, the review focused on applicability of EMS in medical waste management Zimbabwe. EMS involves overall processes that facilitate reduction of dire impacts of company's activities while increasing performance. EMS framework consists of environmental policy, planning, implementation, checking, review and improvement stages. To examine applicability of EMS in management of medical sector waste, published secondary sources with information related to the topic were utilised. Analysis of strengths and opportunities of EMS was used as a base to examine its applicability in medical waste management. Zimbabwean medical sector consist of hospitals and primary healthcare facilities. Medical waste includes pathological, pharmaceutical, cytotoxic, radioactive, chemical, sharp, infectious and general waste. However, twenty-first century witnessed expansion of medical institutions to accommodate COVID-19 patients, resulting in generation of construction and demotion waste. Medical institutions in Zimbabwe are accountable for solid waste management at generation source although municipalities are responsible for conveying solid waste to landfills. Solid waste from medical sector is disposed through traditional strategies namely landfilling, incineration, open pits and open burning, resulting in water, air, and soil contamination. However, EMS can reduce quantity of solid waste disposed through waste reuse, recycle and recovery. Moreover, achievement of integrated approach, effective legislation, policies and inclusive participation in medical waste management is adopted through use of EMS. Therefore, EMS were utilised to develop an integrated sustainable medical waste management model to achieve sustainability.

**Keywords** Environmental Management Systems · ISO 14001 · ISO 45001 · Medical sector · Medical waste · Management approaches

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## Introduction

The world is threatened by various environmental problems encompassing increasing solid waste. Recognising this, Environmental Management Systems has been considered effective in developing sustainable strategies to safeguard the environment and humanity (Chikuku et al., 2011; Gianni et al., 2017; Rino & Salvador, 2017). This tallies with Tarí et al. (2012) and Heras-Saizarbitoria and Boiral (2013) that a number of industries have accepted ISO 14001 management standards. Hence, adoption

of Environmental Management Systems is regarded as a panacea to existing environmental challenges, including medical waste. Mbohwa and Fukada (2002) and Marambanyika and Mutekwa (2009) concur that Environmental Management Systems emerge due to environmental negotiations at Earth Summit of 1992, as panacea to environmental problems. Generally, Environmental Management Systems refer to organisation structure, planning, accountabilities, actions, procedures and resources utilised to develop, implement, review and maintain environmental policy (SAZ, 1996). However, Environmentally Management Systems is defined as a systematic approach to monitor environmental issues and fulfil legal framework and policies while addressing risks as well as opportunities (ISO, 2015; ISO, 2019). Although these definitions differ in wording, but the bottom line is Environmental Management Systems' main goal is to achieve sustainability through continuous improvement. Currently, ISO 45001 (2018) and Ramos et al. (2020) postulated that ISO 45001 is used to improve organisations' performance in terms of occupational health, safety and environmental management. However, ISO 45001 is compatible to environmental, safety and quality standards of its predecessors namely ISO 9001 and ISO 14001. Therefore, integration of the requirements articulated by all these systems in developing measures to safeguard the environment is effectual than conforming to a sole system.

According to Di Noia and Nicoletti (2016), Mas-Machuca and Marimon (2019) and Bravi et al. (2020), adoption of Environmental Management Systems globally is attributed to its ability to pave route for sustainability, for instance, proper management of waste in order to minimise environmental pollution. Application of Environmental Management Systems namely (ISO 14001) in USA increases participation of all stakeholders, legal framework conformity and policy development and gives citizens sense of environmental ownership (Ho et al., 2017; USEPA, 2007). This concur with Ho and Law (2015b) and Fahmi et al., (2021a, b) that adoption of Environmental Management Systems offers feasible environmental management strategies and business improvements in various organisations in a number of countries. This entails that global studies denote that Environmental Management Systems facilitate sustainable environmental management while improving organisation's performance and profits. Nevertheless, in transnational countries like Malaysia, adoption of Environmental Management Systems is less as compared to developed nations as exemplified by Japan and Finland where approximately 90% of companies applied ISO 14001 (Maier & Vanstone, 2005). The situation was also demonstrated by ability of developed countries to quickly implement ISO 45001 standards requirements.

Currently, solid waste management standards are deteriorating in Zimbabwe owing to various political, economic and social constrains (Kwenda et al., 2022; Mafume et al., 2016; Mandevere & Jerie, 2018). However, it is fuelled by failure to adopt and apply Environmental Management Systems such as ISO 14001 and 45,001 standards in management of solid waste. Specifically, in management of institutional solid waste which is already given minute attention in Zimbabwe (Jerie, 2006). Therefore, solid waste from Zimbabwean medical sector is receiving less attention, and assessment of importance of integration of Environmental Management Systems is still evolving. This is in congruent with Mosgaard et al. (2022) that in other countries, application of Environmental Management Systems in dealing with environmental problems is still at infancy stage. In Zimbabwe, studies only focus on effectiveness of integrating Environmental Management Systems in manufacturing industries, for instance, Marambanyika and Mutekwa (2009) at UNILEVER, Harare, Zimbabwe. However, solid waste management particularly medical solid waste is emerging as a major problem in Zimbabwe due to COVID-19 (Dzawanda & Moyo, 2022; Jerie & Musasa, 2022). This is because an increase of medical solid waste overstrains management strategies that were already in limbo. Therefore, exposing waste workers, general public and health workers to various health problems while impacting already fragile terrestrial and aquatic ecosystems (Mangizvo & Chinamasa, 2008; Taru, 2005). Existence of these environmental problems depicts weaknesses of existing management approaches. Therefore, attaching of internationally recognised Environmental Management Systems may assist Zimbabwean medical sector to manage solid waste properly. The reason being ISO Environmental Management Systems are among major tools adopted worldwide to achieve sustainable environmental management including proper management of waste (Marambanyika & Mutekwa, 2009; Ho et al., 2017; Johnstone, 2019b). This

suggests that acquiescence to Environmental Management Systems such as ISO 14001 complemented by current ISO 45001 is a prerequisite in the medical sector. However, effectiveness of Environmental Management Systems in reaching sustainability is determined by existing legal framework, organisation and workers' commitment and available resources (Khanna & Brouhle, 2009; Khanna et al., 2009). Moreover, Boiral and Henri (2012) and Boiral et al. (2018) agree that non-existence of formal approach to conform to when measuring environmental performance accelerates difficulties in assessing benefits of Environmental Management Systems. This is a view upheld by Boiral and Henri (2012) and Sartor et al. (2019) that ability of Environmental Management Systems to narrow the gap to reach sustainability is a debatable issue. Therefore, the skepticism is significance and relevance of pinning Environmental Management Systems in management of waste from medical sector in Zimbabwe. Hence, this paper craves to review the applicability of Environmental Management Systems in waste management in the medical sector of Zimbabwe.

## Study area

The study was done in Zimbabwe, a country with approximately 15.1 million total population, growing at 1.5% yearly (ZIMSTAT, 2022). The population resort to medical sector if they encounter health problems; hence, more solid waste is generated. Medical sector includes both private and public health facilities (Banya, 2018). Ray and Masuka (2017) goes on to say medical sector in Zimbabwe consist of hospital facilities and primary health facilities as shown by Table 1. However, pharmacies located in various areas in Zimbabwe are part of the medical sector.

Zimbabwe is under pressure owing to HIV and AIDS, tuberculosis (Ray & Masuka, 2017), and COVID-19 (UNDP, 2020). However, ailments related to poor sanitation and management of waste such as cholera, typhoid and malaria also exist (Chirisa et al., 2015; Chanza et al., 2017; Chigudu, 2020). This adds burden to the Zimbabwean medical sector waste management, therefore need attention. However, this remains a nightmare since medical sector in Zimbabwe is operating with scanty resources due to country's economic collapse (Chikanda, 2005; Ray & Masuka, 2017). A scenario worsened by slacking in conformity to international standards such as Environmental Management Systems. In Zimbabwe, about 93 ISO certificates were held by various organisations or companies in 2010 (Zengeni et al., 2014). This suggests that adoption of Environmental Management Systems is at infancy stage in Zimbabwe. This is supported by past studies that adoption of Environmental Management Systems is lagging behind in Zimbabwe (Standard Association of Zimbabwe; Mbohwa & Fukada, 2002). However, ISO Environmental Management Systems have demonstrated to be effective in organisations where they are fully implemented in Zimbabwe (Chivandi & Maziriri, 2017; Marambanyika & Mutekwa, 2009). Therefore, complete integration of Environmental Management Systems is essential in solid waste management frameworks in the medical sector to reach sustainability. Hence, this review focused on applicability of Environmental Management Systems in waste management in the medical sector of Zimbabwe.

## Methodology

Literature was retrieved from published secondary sources with information related to Zimbabwean

**Table 1** Profile of medical sector in Zimbabwe

| Hospital facilities | Number | Primary healthcare facilities | Number |
|---|---|---|---|
| Mission hospitals | 62 | Private clinics | 69 |
| Central hospitals | 6 | Polyclinics | 15 |
| Rural hospitals | 62 | Mission clinics | 25 |
| Provincial hospitals | 8 | Rural health centre | 307 |
| District hospitals | 44 | Municipal clinics | |
| | | Clinics | 1122 |
| Total | 214 | | 1634 |

Source: Ray and Masuka (2017); Ministry of Health and Child Care (2016–2020

medical sector solid waste generated and management strategies. Data linked to ISO Environmental Management Systems notably ISO 14001 and ISO 45001 was reviewed. In Zimbabwe, researches on medical sector solid waste are limited; therefore, literature focusing on other types of waste but with aspects medical waste was included. Information on synergies between Environmental Management Systems and solid waste are rare to find; hence, publications linked to various companies and institutions were considered. English secondary data sources were reviewed to meet demands of the study. In order to strengthen the paper's reliability and validity, in-text and end-text citation was done; however, literature related to Zimbabwe was compared to other publications made across the globe. Information which suffice demands of the topic under study was recovered from journals, books, articles, abstracts, book chapters and published dissertations. Existing data was retrieved from PubMed, Sage Publications, Science Direct, Google Scholar, Springer and Scopus coupled by Web of Science Publications. In order to speed information retrieval process, key words typed on search engines encompass ISO 14001, ISO 45001, Environmental Management Systems alongside solid waste and medical solid waste. Analysis of the applicability of Environmental Management Systems in waste management in the medical sector was done through SWOT analysis. This strategy was used by Pesce et al. (2018) when applicability of ISO 14001 in the Chinese context was examined. SWOT means Strength, Weaknesses, Opportunities and Threats (Madsen, 2016; Teece, 2017). However, this review put emphasis on strengths which are positive characteristics of Environmental Management Systems which have potential to strengthen medical sector's waste management strategies. Moreover, Opportunities which refer positive factors which can arise due to utilisation of Environmental Management Systems in monitoring of medical waste were included. Development of an integrated sustainable solid waste management system was based on Environmental Management Systems continuous framework coupled by the Plan, Do, Check, Act model.

## Composition of solid waste generated from Zimbabwean medical sector

Medical facilities such as private and public hospitals or clinics produce solid waste during immunisation, treatment and caring of people who seek health assistance (Mangizvo & Chinamasa, 2008). However, pharmacies in city centres are part of the medical sector, since they generate solid waste with similar characteristics to medical waste. Medical sector solid waste encompass infectious waste, chemical, radioactive, sharps, pharmaceutical waste, cytotoxic and chemical waste as indicated by Table 2 (Taru, 2005), and pathological waste (Jerie & Musasa, 2022). This suggests that solid waste from medical sector in Zimbabwe is partially hazardous and non-hazardous waste. This corroborates with Environmental Management Agency (2007) and Mangizvo and Chinamasa (2008) that medical institutions in Zimbabwe are projected to produce 85% non-perilous waste while 15% is hazardous. This clearly means 15% of solid waste from medical sector in Zimbabwe contains characteristics like reactivity, flammability, corrosivity, explosivity, ignitability and irritability. Furthermore, medical sector in Zimbabwe is emerging and generates electronic waste in form of non-functioning computers, landlines, printers, sanction machines and cartridges. This is a view supported by Chijarira (2013), Chitotombe (2013) and Gweme et al. (2016) that Zimbabwean municipal solid waste consists of electronic waste from various sources.

Additionally, Chikobvu and Makarati (2011) and Jerie (2013) revealed that in Zimbabwe textile waste in form of cloth pieces and tattered clothes is part of waste collected by municipalities. Consequently, medical sector add substantive quantity of textile waste since it produce old tattered blankets and clothes from sewing and laundry departments. In Zimbabwe, expansion of various organisations and institutions results in generation of construction and demolition waste including broken bricks, piles of stones, sand and broken metals and glasses (Jerie, 2013; Moyo & Chigara, 2021). Therefore, construction and demolition waste result from medical sector construction alongside expansion in order to accommodate increased number of patients with infectious diseases like COVID-19. Table 2 illustrates that infectious solid waste from medical facilities includes blood and fluid contaminated gloves, beddings, blankets, dressings, plaster caster, swabs, bandages and sponges generated from wards like isolation with people infected by communicable diseases (Mangizvo & Chinamasa, 2008; WHO, 2017) (Table 2). Nevertheless, waste from medical sector in form of infectious

**Table 2** Composition of solid waste from medical sector in Zimbabwe

| Hazardous waste | Description | References |
|---|---|---|
| Pharmaceutical waste | Drug left overs and remains, expired drugs, contaminated drugs | Medicines Control Authority of Zimbabwe, (2020); Nyakatswau et al. (2022) |
| Pathological waste | Body fluids, unused blood products, body parts, human tissues and organs | Jerie and Musasa (2022) |
| Sharp waste | Needles, blades, infusion sets, broken glasses, knives, pipettes and syringes with attached needles | Taru (2005); Haji et al. (2020) |
| Radioactive waste | Unsealed radio nuclides, absorbent paper and contaminated glassware | Mangizvo and Chinamasa (2008)<br>Ali et al. (2017) |
| Chemical waste | Remains of disinfectants and detergents, laboratory reagents, heavy metals from broken blood pressure gauges and thermometers | Jerie, (2016); WHO (2020) |
| Infectious waste | Contaminated cotton wool, gloves, dressings, swabs, beddings, plaster caster and specimen containers/ bottles | Taru (2005); Mangizvo and Chinamasa (2008) |
| Non-hazardous waste | | |
| General waste | Stationary, food waste, non-spoiled empty boxes and soft drink bottles | Jerie (2006); Tsiko and Togarepi (2012) |

Medicines Control Authority of Zimbabwe (2020); Nyakatswau et al. (2022); Jerie and Musasa (2022); Taru (2005); Haji et al., (2020); Mangizvo and Chinamasa (2008); Ali et al., (2017); Jerie (2016); WHO (2020); Jerie (2006); Tsiko and Togarepi (2012)

waste in Zimbabwe increased due to over spilling of COVID-19 into Zimbabwe. This is in congruent with UNDP (2020) that increasing of infectious of waste from medical sector is attributed to increase utilisation of personal protective equipment and clothing namely masks, gloves and gowns. However, human tissues infected by viruses and bacteria are considered as infectious waste (WHO, 2020). In the Zimbabwean context, healthy and unhealthy body parts, human tissues, placentas and foetuses from stillbirth are part of pathological waste from medical sector as shown by Table 2 (Jerie & Musasa, 2022). This implies that solid waste which quickly decomposes such as detached human flesh is generated by Zimbabwean medical sector; therefore, adequate collection rate is required.

Moreover, pharmaceutical waste exemplified by contaminated and expired drugs, their containers and drug left overs are generated by medical sector in Zimbabwe (Medicines Control Authority of Zimbabwe, 2020; Nyakatswau et al., 2022). However, in Zimbabwe, pharmaceutical waste from medical institutions is low owing to shortage of finance which enables apt planning during purchasing and usage of drugs; nevertheless, drugs left by the deceased are always available. According to Mangizvo and Chinamasa (2008), medical sector notably hospitals and clinics are sources of radioactive waste owing to therapeutic procedures, use of unsealed radio nuclides, nuclear medicines and absorbent paper. Considering this, Zimbabwean medical sector is capable to generate solid waste which is mutagenic and carcinogenic, hence needs attention. An idea confirmed by Ali et al. (2017) and the WHO (2020) that medical facilities are sources of radioactive solid waste which pose detrimental effects to humanity. Taru (2005) asserted that infusion sets, pipettes, scalpels, knives, needles, broken glasses, nails and syringes from hospitals are regarded as sharp waste. Therefore, this denotes that medical sector in Zimbabwe generate waste with potential to cause pricks, cuts and injuries (Table 2). This is in congruent with studies which indicated that sharp waste pose injuries facilitate the spread of diseases such as hepatitis, HIV and AIDS (Kalogianndou et al., 2018) as well as COVID-19 (Haji et al., 2020). Hence, medical sector waste generators and workers should pay adequate attention and use personal protective equipment properly when dealing with sharp waste.

In the Zimbabwean context, containers such as bottles with residues of disinfectants, solvents, reagents

and sterilant among others and heavy metals such as mercury are part of chemical waste (Jerie, 2016). This suggests that medical sector which is home of diagnosing chemicals generates various types of chemical waste from equipment cleaning, patient treating and broken blood pressure gauges and thermometers which produce mercury. Jerie (2006), Mangizvo and Chinamasa (2008) and Tsiko and Togarepi (2012) postulated that medical institutions produce general solid waste such as plastics, papers from offices, food waste from hospital wards and kitchen and food and flowers brought by patients' relatives. This depicts that medical sector in Zimbabwe generates a certain type and quantity which can be recycled and reused if properly managed from point of generation to disposal. However, in Zimbabwe, management of solid waste is marred with chaos since different solid waste types are stored and disposed together (Remigios, 2010; Tsiko & Togarepi, 2012). As a result of indiscriminate storage of waste, solid waste from Zimbabwe's medical sector become wholly hazardous.

## Current solid waste management approaches utilised in the medical sector

### Storage

In the Zimbabwean context, medical sector solid waste is stored in small containers in patients' wards, and if the containers are full, they are emptied in large bins placed in corridors (Mangizvo & Chinamasa, 2008). This implies that solid waste is stored in areas where patients, visitors and health workers can be exposed to negative impacts of waste. According to Taru (2005), indiscriminate storage of solid waste is visible in medical sector, since pharmaceutical, general and sharp waste is stored together. However, this contradicts with Zimbabwe's Ministry of Health Child Care and World Health Organisation waste management guidelines. During storage stage, when the containers are filled to capacity medical solid waste spill to the floor (Mangizvo & Chinamasa, 2008; Taru, 2005). Therefore, people became vulnerable to injuries when they step on sharp waste such as needles and razor blades. Henceforth, improper storage of waste is the root of improper management of solid waste in the Zimbabwean medical sector. This is a view upheld by Musademba et al. (2011) and Zikali et al. (2022) that storage and collection of non-segregated solid waste are among the challenges which hinder apt management of waste in Zimbabwe.

### Collection and transportation

Solid waste onsite collection and transportation is carried out by the medical institution. This concurs with Mangizvo and Chinamasa (2008) that onsite collection as well as conveyance to onsite storage areas and waste site is done by hospital waste workers using mobile trolleys. This clearly means medical sector in Zimbabwe are accountable for onsite management of waste. However, collection and transportation of waste from hospitals and clinics are a responsibility of municipalities. This is clearly stipulated by the Urban Council Act Chapter 29: 15 that municipalities are accountable for providing services including waste collection to areas under their jurisdiction (Jerie, 2013; Ministry of Local Government and Public Works, 2021). Nevertheless, only medical sector facilities located in urban areas are beneficiaries of the Act, therefore need to be assessed and upgraded. Solid waste generated in Zimbabwean urban centres including from institutions is collected to areas of final disposal like official dumpsites and landfills by municipalities (Chatira-Muchopa et al., 2019; Jerie, 2006); hence, medical institutions are included. However, according to Makarichi et al. (2019) and Kwenda et al. (2022), solid waste collection in Zimbabwe is characterised by delays, inefficiency and erratic owing to shortage of fuel, financial and refuse trucks. Kwenda et al. (2022) go on to say waste collection rate is approximately 60% in Zimbabwe. Therefore, medical sector in Zimbabwe is not spared by inadequate collection and conveyance.

However, considering the sub-tropical climate in Zimbabwe solid waste is ought to be transported to disposal sites at least two times per week (Mandevere & Jerie, 2018; Munyai & Nunu, 2020). However, Nyatsanza and Kudzai (2016) and Munyai and Nunu (2020) concur that in Zimbabwe, solid waste from various sources is collected once a week or month. This revealed that waste collection rate offers solid waste from medical sector opportunity to continue accumulate and decompose at onsite areas. However, in order to conform to World Health Organization prerequisites, solid waste from medical sectors should be carried out daily (Jerie & Tevera, 2014;

Taru, 2005). Consequently, besides contradicting local Ministry of Health and Child Care requirements, collection system of medical waste is parallel to international standards. This is worsened by poor planning exhibited by deployment of waste collection trucks without providing maps depicting routes to be followed by drivers (Chikobvu & Makarati, 2011; Mandevere, 2015; Mandevere & Jerie, 2018). Consequently, this haphazard collection approach results in skipping of other medical facilities such as hospitals and clinics, therefore affecting the medical sector negatively. This also results in decomposition of medical waste such as pathological waste stored at skipped health institutions; hence, people in the vicinity became vulnerable to environmental health risks that emanate from waste. Moreover, owing to inadequate solid waste collection and conveyance in Zimbabwe, people resort to improper disposal strategies namely onsite burning, burying and illegal dumping (Dzawanda & Moyo, 2022; Mafume et al., 2016; Pawandiwa, 2013). Therefore, unreliable solid waste collection also forces medical institutions to free their onsite waste storage areas using various rudimentary disposal approaches.

## Treatment and disposal

In Zimbabwe, disposal and treatment of solid waste are based on conventional approaches for instance composting, incineration, open burning and landfills (Jerie & Jenya, 2020; Makarichi et al., 2018). This is a view upheld by Dzawanda and Moyo (2022) that in Zimbabwe, waste management hierarchy's least desired solid waste disposal approaches are utilised. Hence, this exhibits that solid waste from the Zimbabwean medical sector is treated and dumped through approaches which form the base of waste management hierarchy triangle. In Zimbabwe, 90% of solid waste including medical waste is disposed (Mandevere, 2015); however, Nhubu et al. (2019) indicated that 40% is destined on illegal dumpsites. Taking into account the quantity of waste disposed, it is clear that facets of integrated solid waste management at country level and medical sector specifically are ignored. In Zimbabwe, a large quantity of medical waste is treated through incineration (Jerie & Musasa, 2022; Taru, 2005). Additionally, a certain volume of medical waste is destroyed via open combustion, since Makarichi et al., (2018) stated that 37.6% Zimbabwean solid waste is burned at source of generation. However, incineration and open burning are known to be sources of pollutants such as nitrous oxide, carbon monoxide, carbon dioxide, dioxins, furans, fumes and smoke (Remigios, 2010; Ali et al., 2017). All these end products of combustion processes result in air contamination and respiratory problems namely asthma and persistent coughing, while some of them are carcinogenic (Jerie, 2016; Tsiko & Togarepi, 2012). As a result, it is pathetic that solid waste from medical sector is degrading environmental quality while causing numerous health ailments. Furthermore, in the Zimbabwean context, disinfection of medical infectious waste is done through autoclaving as well as chlorination (Mangizvo & Chinamasa, 2008). As a result, before destined in disposal sites like landfills, waste from medical sector goes through processes which destroy viruses and bacteria. However, Taru (2005) and Mangizvo and Chinamasa (2008) coincide that these methods are infrequently applied since they are regarded as expensive in countries like Zimbabwe. This revealed that economic meltdown coupled by sky rocketing inflation in Zimbabwe is impacting management of waste from medical sector.

In Zimbabwean cities, about 270 tonnes to 500 tonnes of solid waste generated in Zimbabwean urban centres daily is disposed in landfills (Kwenda et al., 2022; Nemadire et al., 2017). Henceforth, medical solid waste generated from medical facilities in cities is destined in landfills. However, the problem is landfills in Zimbabwe are not constructed to standard since they are unlined and lack gas and leachates outlets (Mahamba, 2015; Kharlamova et al., 2016). A scenario worsened by management of landfills as open dumpsites in Zimbabwe (Nemadire et al., 2017). Therefore, landfills which receive medical waste have potential to cause air, water and soil pollution; hence, strategies to move away from conventional disposal strategies are required. Jerie (2016) and Makarichi et al. (2018) opined that in Zimbabwe, erratic waste collection results in disposal of solid waste in open pits excavated at open spaces. However, leachates from decomposing medical waste result in ground water pollution, since the pits are always unlined. This is evidenced by burying of solid waste in unlined pits in Zimbabwean cities (Mafume et al., 2016), but it is practised at lower rate. However, medical institutions in rural areas apply it at high rate as compared to urban hospitals.

Discussion of treatment and disposal strategies used by medical institutions in Zimbabwe demonstrates backwardness and reluctant in adopting new ideas. This is a view upheld by Chandak (2010) that most African countries utilise conventional disposal approaches. However, 10 to 13.6% of solid waste generated in Zimbabwe goes through recycling, reusing and recovery alongside composting (Kharlamova et al., 2016; Nhubu et al., 2019). However, environmental consciousness results in embracing of methods diverting solid waste from disposal route in Zimbabwe, but the alternatives are used at lower rate. Barriers to adoption of sustainable solid waste management in Zimbabwe is attributed to weakly enforced legislation (Jerie, 2013), financial constraints and unawareness among waste generators and handlers coupled by utilisation of inadequate data (Dzawanda & Moyo, 2022; Nhubu & Muzenda, 2019; Zikali et al., 2022). Therefore, management of solid waste from Zimbabwean medical sector is evolving slowly due to these challenges. Hence, to catalyse the evolving process and circumvent obstacles in waste management, Zimbabwe must pin Environmental Management Systems such as ISO 14001 in solid waste management (Jerie & Jenya, 2020). Therefore, application of Environmental Management Systems in management of solid waste from medical sector can go a mile in narrowing the gap to reach sustainability. This is a view supported by Nadae and Carvalho (2019), Toha et al. (2020) and Bell and Voorhees (2020) that Environmental Management Systems such as ISO 14001 and ISO 45001 frameworks are currently regarded as models to reach opportunities for sustainability.

## Profile of Environmental Management System components

According to Stapleton et al. (2001) and Khanna et al. (2009), the paramount component of Environmental Management Systems is commitment of company or organisation. Accordingly, Environmental Management Systems bear fruits if the organisation is fully committed and supported by willing employees. However, other crucial components encompass environmental policy and the plan, do, check and act structure. Environmental policy stipulates that there should be synergy between environmental activities and organisation's vision, objectives and mission (ISO 45001, 2018; Sheldon and Yoxon, 2012). However, policies should be accompanied by effective legal framework, which support reduction of environmental degradation. Identification of environmental impact where an organisation is required to figure out detrimental impacts associated with its activities and operations. Therefore, impacts of solid waste generated are not spared. Internal or external environmental auditing can be carried to understand significant impact of manufactured or disposed product. Environmental auditing acts as the bedrock to develop company's environmental objectives and targets (ISO, 14, 001, 2015; Arimura et al., 2016), as depicted in Fig. 1. Developing of stringent goals facilitates continuous improvement and reduction of environmental impacts if all stakeholders are involved. Consultation of everyone at an institution or organisation is crucial, since it enables sharing of ideas used during environmental policy and objective development.

Moreover, all company's procedures, activities and operations must conform to the implemented policies and goals in operational control process. However, according to Stapleton et al. (2001) and Sheldon and Yoxon (2012), complete planning is required when setting out and implementing environmental policies, goals, legislation and reviewing them. This means proper planning buttress all Environmental Management System elements. The components depicts that all planned objectives, legal frameworks and procedures should be recorded during the documentation processes for future use. This postulates that documentation process is crucial when carrying out reviewing stage. Environmental Management Systems denote that accountability and roles of stakeholders involved should be clearly stipulated in order to implement Environmental Management Systems effectively. All responsible participants are supposed to go through environmental education and training programmes to gain knowledge and skills linked to their roles. Hence, this stage equips organisation and its employees with adequate environmental awareness since they are motivated. Weiß and Bentlage (2006) and ISO (2019) stipulated that in order to ensure, determine compliance and assess effectiveness of the implemented environmental legal frameworks and targets, reviewing audits should be done. This implies that this stage pave way for endless environmental monitoring improvement. Figure 2 denotes

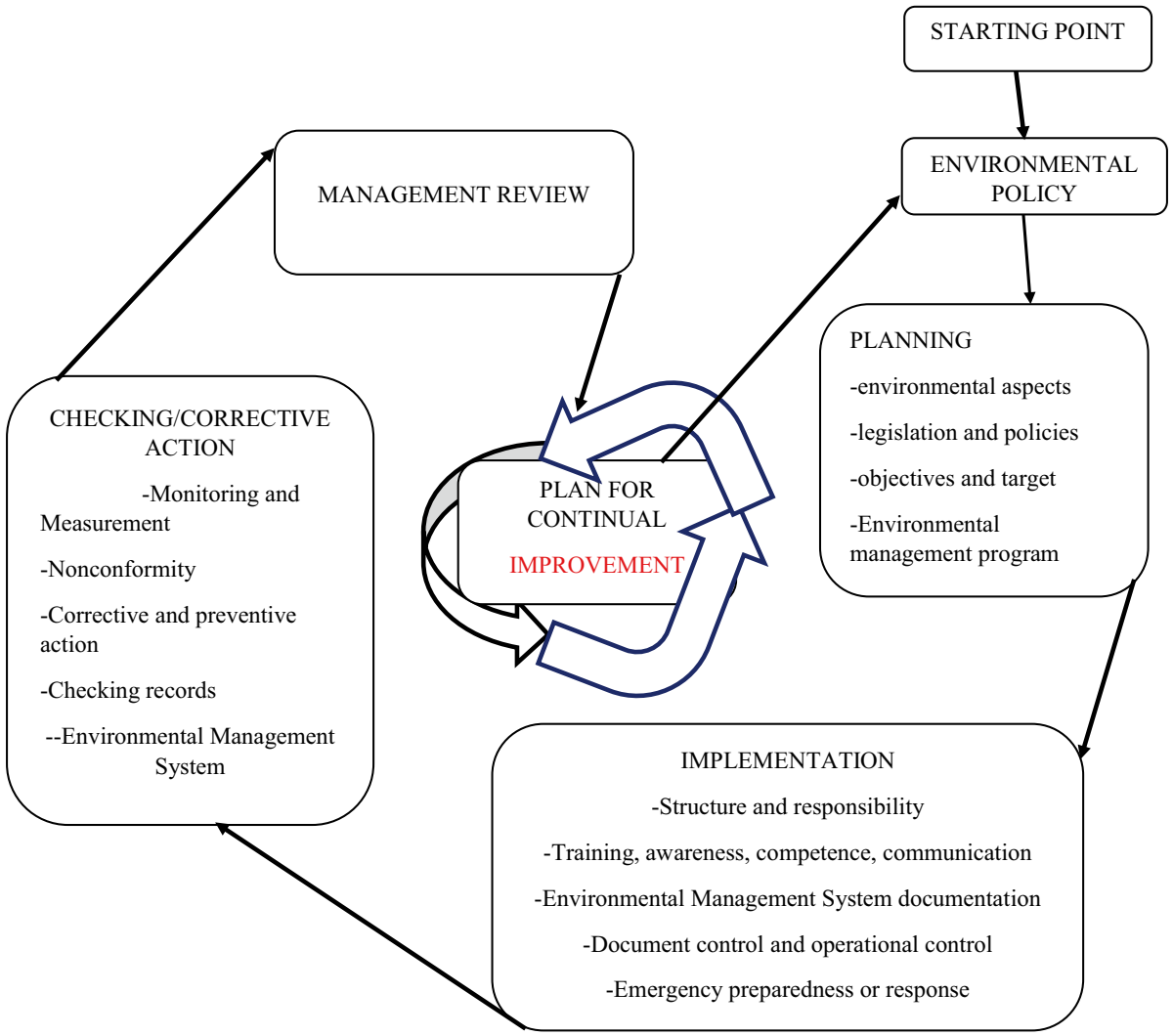


**Fig. 1** Environmental management system continuous framework. Source: ISO 14001 (2015); ISO 45001 (2018)

that Environmental Management Systems use continuous improvement process where the reviewed and examined systems are improved to strengthen them (Weiß & Bentlage, 2006; ISO 14001, 2015; Arimura et al., 2016). This enables the management systems to be effective, thus reducing negative environmental impacts associated with organisation's activities. Continual improvement process to achieve sustainability is guided by the Plan (P)-Do (D)-Check (C)-Act (A) (PDCA) framework shown in Fig. 2. This is a view upheld by Dubberly (2008) and Moen and Norman (2009) that PDCA methodology is the widely utilised continuous improvement.

## Analysis of Environmental Management Systems

Synthesis of Environmental Management Systems revealed that adoption of the systems improves decision-making in safety and environmental aspects. The systems support integration of ideas from various stakeholders, thus enabling sharing knowledge. The apparatus of the systems facilitates inclusion of political, social and economic aspects in environmental management. Hence, establishment of sustainable approaches to reduce human footprint on the environment is minimised. Moreover, reviewing demonstrate that Environmental Management System can be applied by any company with potential to

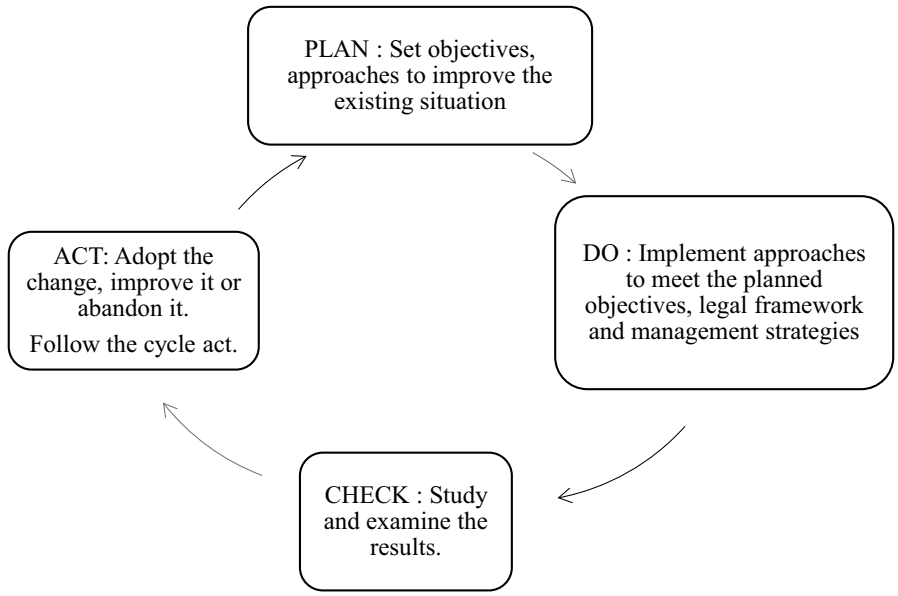


**Fig. 2** Plan-Do-Check-Act model. Source: Dubberly (2008); Moen and Norman (2009)

pose detrimental impacts to the environment. This implies that medical sectors can also adopt the systems to improve their performance, since they generate waste. Environmental Management Systems are crucial in planning and implementing strategies which narrow the gap to reach articulated environmental management approaches. Consequently, medical sectors have potential to benefit if they pin the systems' components in solid waste management. Furthermore, concepts in Environmental Management Systems act as guidelines to managers and employees in understanding key aspects which can be linked to environmental management. This reveals that medical sector managers and employees can relate Environmental Management Systems in their environmental management goals, vision and mission. Additionally, the continuous improvement model enable organisations to overcome barriers they encounter when crafting and implementing proper environmental management methods. Considering this, medical sectors are capable to achieve sustainable solid waste management through adoption Environmental Management System requirements and continuous model.

## Opportunities associated with integration of Environmental Management Systems in medical waste management in Zimbabwe

According ISO 14001 (2015) and Wheatley (2019), Environmental Management Systems are applicable in management of solid waste, since it articulates that solid waste must be stored according to their characteristics in clearly labelled receptacles. Conforming to these requirements means hazardous and non-hazardous solid waste from medical sector is stored separately. Hence, management of medical waste became easy due to proper segregation. Environmental Management Systems facilitates understanding of ecological footprints of the organisation's activities and development of strategies to improve its performance (Ikram et al., 2019; Fahmi et al., 2021a, 2021b; Mosgaard et al., 2022). Therefore, EMS aspects act as a foundation to proffer sustainable environmental goals and polices aimed at promoting medical sector's performance in terms of solid waste management. Hence, narrow the gap to achieve global goals such as Goal 11 of sustainable cities and communities in the medical sector. Amiri et al. (2015) and Hutagalung and Yanthy (2020) opined that Environmental Management Systems increase organisation's environmental accountability and employees' knowledge towards environmental management and performance. This suggests that attaching of Environmental Management Systems enables medical facilities to be responsible for solid waste they generate, instead of waiting for municipalities. Therefore, lowering of environmental effects associated with medical waste became a visible tail end issue, hence creating a noble image of medical sector. Application of ISO 14001

standards enable adoption of Life Cycle Analysis and Life Cycle Costing in assessment of impacts that emanate from materials used in various organisations (Bravi et al., 2020; Guenther et al., 2016; Johnstone, 2020). As a result, Environmental Management Systems facilitates carrying out of environmental impact assessment of products utilised and produced by medical facilities, therefore, enabling medical sector to purchase and utilise sustainable products which result in reduction of waste.

Moreover, Jonstone (2019b, 2020) argued that Environmental Management Systems offer route for continual improvement since they are connected to Plan, Do, Check, Act model. This means the systems act as a base to carry out planning strategically and develop cyclical continuous strategies which enhance proper management of waste from medical sector. Fahmi et al., (2021a, 2021b) and Jonstone (2019b) coincide that the purpose of Environmental Management Systems is to guide implementation of policies that reduce pollution and climate change. Hence, it facilitates utilisation of processes and products which meet environmental legal frameworks in medical sector in order to prevent pollution. This clearly means pinning of Environmental Management Systems in the medical sector assists Zimbabwe to attain Goal 13, of Climate Action. ISO 14001 Environmental Management Systems enable various technological systems to be applied in management of firms (Prakash & Patoski, 2014; He and Shen, 2019; Pesce et al., 2018). Consequently, the systems facilitate utilisation of tools like Geographic Information System and Global Positioning System in locating suitable disposal sites for medical waste. Also, proper engineering can be applied in construction of incinerators and landfills, hence lessening environmental risks associated with improperly constructed medical waste disposal and treatment facilities.

ISO 14001 management system assists in lowering energy utilisation and raw material cost and waste minimisation through supporting enhanced recycling (Amiri et al., 2015; Fahmi et al., 2021a, 2021b). This clearly means application of Environmental Management Systems in the medical sector reduces the quantity of solid waste disposed since waste is converted into new products. According to Jerie and Jenya (2020), application of Environmental Management Systems paves way to recover energy from generated waste. This means Environmental Management Systems can enable medical waste to be used as source of energy, which is already scarce in Zimbabwe. This suggest that application of Environmental Management Systems result in achievement of Goal number 7, which put emphasis on affordable and clean energy. Chivandi and Maziriri (2017) and Kristensen et al. (2021) asserted that conformity to demands of ISO Environmental Management Systems results in implementation of integrated management approach at an organisation. Therefore, embracing of Environmental Management Systems enables medical sector to phase out conventional solid waste management strategy and adopt integrated approach.

Operating according to the requirements of ISO 14001 and ISO 45001 equip the company with competitive merit owing to improved manufacturing, marketing and proper environmental management (Purwanto, 2019; Purwanto et al., 2020). Consequently, besides building good relationship with the clients, medical facility's catchment area increases; therefore, profit increased. In terms of client increase, good reputation attracts clients from within and outside health institutions' catchment area. Similarly, profit is increased due to increase of clients and by conforming to environmental policies risks of litigation and penalties directed to environmental mismanagement is reduced, thus saving finance. This is in line with Chiarini (2016) and Kakouris and Sfakianaki (2018) that adoption of ISO Environmental Management Systems enables an organisation to gain external and internal benefits as well as fuelling all stakeholder participation. This suggests that all individuals and organisations accountable for management of waste from medical sector are given opportunity to develop legislation, policies and strategies aimed to achieve proper waste management. This is a view noted in Sustainable Development Goal 17 that there is need for partnership during implementation of sustainable strategies (United Nations General Assembly, 2015). This coincides with He and Shen (2019) and Purwanto et al. (2020) that Environmental Management Systems consider all stakeholder participation and communication as well as documentation of appropriate information as key elements to achieve sustainability. As a result, records concerning medical sector waste which facilitates easy planning are kept if Environmental Management Systems are properly applied.

Moreover, Environmental Management Systems enable effective communication among company

employees (Gianni et al., 2017; He and Shen, 2019; He et al., 2015). Consequently, medical waste management procedures are carried out aptly owing to proper sharing of information among those responsible for waste management at workplace. Asbari et al. (2019) and Hutagalung and Yanthy (2020)opined that workers' performance and morale is boosted if ISO 45001 system is pinned to company's management system since it supports work safety of employees. This revealed that Environmental Management Systems play a pivotal role in reducing occupational hazards associated with activities involved in management waste within the medical sector. Therefore, drive Zimbabwean medical sector to reach Goal number 8, which clearly articulate that workers should be exposed to decent work. Companies or organisations who adopted and implemented ISO 45001 Occupational Health Safety Systems are expected to experience rapid expansion and massive production due to reduced workplace injuries (Murmura et al., 2018; Campailla et al., 2019). Therefore, the essential value of Environmental Management Systems in the medical sector is to prevent occupational health risks through controlling human behaviour. This suggests that biological, chemical, physical and ergonomic health risks that may affect health workers and waste workers are minimised.

Additionally, Chikuku et al. (2011) and Kakouris and Sfakianaki (2018) coincide that monitoring and reviewing of company's compliance to environmental safety standards are done if Environmental Management Systems are used. Therefore, Environmental Management Systems help the medical sector to minimise financial loss, since payment of fines to Environmental Management Agency is reduced. Also, Environmental Management Systems enable checking of medical sector's conformity to legal framework and existing management approaches through auditing, hence leading to sustainability. Bravi et al. (2020) and Mosgaard et al. (2022) noted that ISO 14001 Environmental Management Systems provide tools to companies willing to content environmental effects of their daily activities, therefore paving route for medical sector to achieve requirements of Agenda 21 and Sustainable Development Goals 11.6. This is in congruent with studies which highlight that Environmental Management Systems narrow the gap to attain sustainability since they have potential to override existing constrains (Carruthers & Vanclay, 2012; Gianni et al., 2017; Mosgaard et al., 2022).

In Zimbabwe, management of medical waste is hindered by the lack of resources and finance (Mangizvo & Chinamasa, 2008; Taru, 2005), hence to overcome the barriers; Environmental Management Systems should come into play. Nations who have adopted ISO 45001 Environmental Management Systems are required to reduce emissions to the required standards in order to avert air pollution (Mas-Machuca & Marimon, 2019; Bugdol et al., 2020). Following this, to phase out waste disposal approaches like incineration and open burning which pose air contamination, Zimbabwean medical sector should adopt Environmental Management Systems. Organisations who adopt Environmental Management Systems standards are obliged to comply with national and international environmental policies and legal framework (Tarí et al., 2012; Bugdol et al., 2020; Kristensen et al., 2021). This revealed that if medical sector apply EMS in waste management, issues of litigation, environmental fees, penalties and bills are reduced owing to conformity to national and international waste management standards. According to He et al. (2015); Ikram et al. (2019) and Fahmi et al., (2021a, 2021b), ISO 14001 and ISO 45001 Environmental Management Systems framework denotes that training is crucial in increasing workers' awareness towards environmental aspects at a workplace. Therefore, adoption of Environmental Management Systems enables medical sectors to carry out waste management training, hence enhancing knowledge of waste workers. This is in congruent with Gadenne et al. (2012) and Jerie and Jenya (2020) that Environmental Management Systems assist in alteration of workers' attitudes towards management of the environment. Therefore, consciousness among medical waste handlers promotes proper waste management, thus reducing environmental risks. However, Lepoutre and Heene (2006) postulated that motivations and adoption of Environmental Management Systems depend on size and type of organisations. This implies that although Environmental Management Systems are influential and effective, their relevance varies among numerous organisations, and medical sector is not spared. Nevertheless, considering the aforementioned benefits, it is clear that Environmental Management Systems are applicable in the

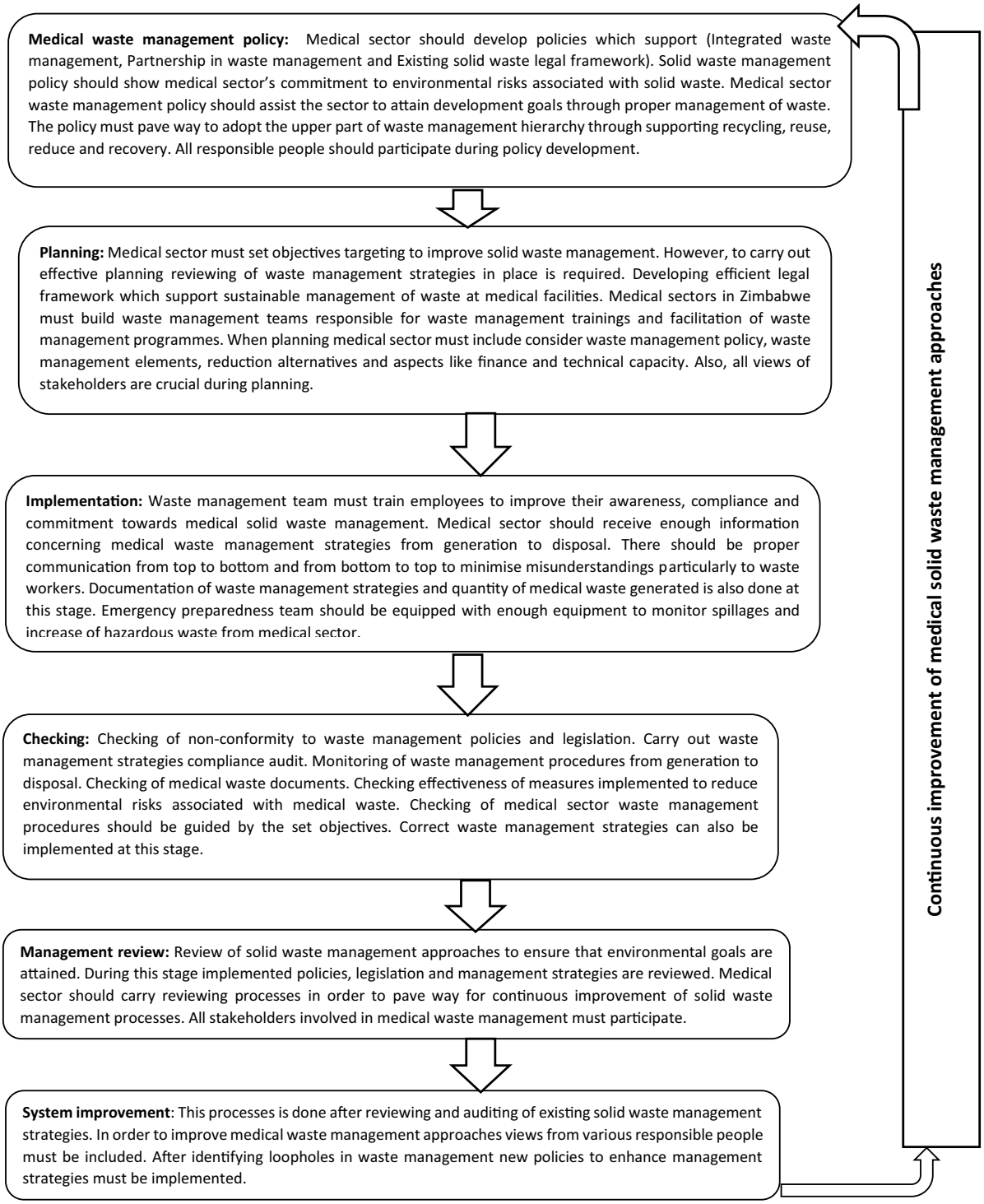


**Fig. 3** Medical waste management model developed basing on Environmental Management Systems. Source: Authors

management of waste from the medical sector. Figure 3 denotes how Environmental Management Systems elements such as policy, planning, implementation and reviewing can be applied to improve medical waste management in the medical sector.

## Conclusion

Literature reviewed indicated there is scanty literature related to Environmental Management Systems and solid waste management, particularly in the medical sector. However, generation of large volume of solid waste is inevitable due to population increase, HIV and AIDS, COVID-19 coupled by outbreak of poor sanitation ailments like cholera and typhoid. Medical sector in Zimbabwe consists of district, central, rural, provincial, mission hospitals and clinics which generate solid waste. Solid waste from medical sector consists of hazardous and non-hazardous waste namely infectious waste, chemical, pharmaceutical, pathological and radioactive among others. Management of solid waste from medical sector is conventional, characterised by indiscriminate storage, collection and disposal. Medical solid waste is treated and disposed through incineration, open burning, landfilling and open pits. Findings revealed that disposal strategies used have potential to affect terrestrial, aquatic and atmospheric ecosystems negatively. Verdicts of the study demonstrated that utilisation of rudimentary strategies is attributed to inadequate resources and data, ineffective legal frameworks, low policy follow-ups coupled by unconsciousness among waste generators and handlers in the medical sector.

Moreover, published documents show that adoption of Environmental Management Systems can avert environmental risks associated with improper management of medical waste while improving medical sector performance. Environmental Management System components that facilitate sustainability include environmental policy, planning, implementation, checking, management review and plan for continual improvement. Therefore, results depict that application of Environmental Management Systems enables Zimbabwean medical sector to recycle waste into new products and convert solid waste into fuel, gas and electricity. In addition, already existing solid waste legislation and policies are strengthened and amended. However, Environmental Management Systems offer foundation to create and implement new legislation and policies that focus on medical solid waste. Through Environmental Management Systems, proper planning exists since all stakeholders are involved. Continuous improvement of waste management strategies became part of medical waste management system, since Environmental Management Systems use the Plan-Do-Check-Act structure. Furthermore, Environmental Management Systems guarantee occupational safety of health workers and waste workers, therefore increasing morale of workers in the medical sector. Reviewed literature signifies that adoption of Environmental Management Systems minimise revenue loss from the medical sector, since litigation and environmental fines are reduced. Hence, reviewed information as well as SWOT analysis presents the strengths, opportunities and applicability of Environmental Management Systems in management of waste from medical sector. Consequently, an integrated sustainable medical waste management model in Fig. 3 was developed in order to assist Zimbabwean medical sector to apply Environmental Management Systems in solid waste management. The model demonstrates elements of Environmental Management Systems that can be applied to improve management of solid waste in the medical sector. The model in Fig. 3 denotes strategic approaches to benchmark existing management strategies and offering guidance to decision-makers involved in management of medical waste.

**Author contribution** Takunda Shabani (T. S): Preparation and writing of original draft.

Steven Jerie (S.J): Reviewing and formal analysis of the review.

**Data availability** The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

### Declarations

**Ethics approval** All authors have read, have understood, and have complied as applicable with the statement on 'Ethical responsibilities of Authors' as found in the Instructions for Authors and are aware that with minor exceptions, no changes can be made to authorship once the paper is submitted. Approval was granted by Midlands State University to carry out

the research as well as to publish under its name. All sources were properly cited to avoid plagiarism.

**Consent to participate** All authors participated and agreed to participate up to final revision of the manuscript.

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