Proceedings of GLOGIFT 17
December 11-13, 2017
Delhi School of Management, Delhi Technological University, Delhi
pp. 261-274

Developing Multi-criteria Based Decision Support Framework for Sustainable Healthcare Waste Management in India

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Abstract

Today, healthcare waste management is a burning issue across the world. Reports have been released regularly by various international and local bodies for creating awareness about the hazardous impact of healthcare waste on humans and animals. World Health Organization (WHO) has been actively playing role in improving the situation of healthcare waste management by seamlessly emphasizing onthe significance of creating awareness, technological, and managerial solutions. The technological innovations are majorly unaffordable for adoption for the management of healthcare waste in developing countries whereas the effective managerial solutions are not available to the key decision makers, i.e. hospitals and healthcare waste disposal firms,for implementation. Keeping in view to the various constraints including budgetary constraints, an effective managerial solution to key decision makers,in terms of amulti-criteriadecision support framework, has been proposed in this study. This decision support framework can be easily adopted and implemented for improving the situation of healthcare waste management in developing countries across the world.

Keywords: Healthcare waste, Hospitals, Healthcare waste disposal firms, Multi-criteria decision making methods, Optimization and Statistical Modelling, Sustainability.

Introduction

The waste that comes out of different healthcare facilities such as clinics, nursing homes, hospitals, pathology labs, and medical research centres, has been categorized as healthcare waste (WHO, 2013). This waste consists of blooded cottons, bandages, infected syringes, scalpels, body parts, chemicals, cytotoxics, and radioactive materials (Pruss et al., 1999). The presence of the mentioned infectious and hazardous components converts healthcare waste into a life taking object for humans as well as animals(Chauhan and Singh, 2016). The improper disposal of infectious syringes and scalpels plays a major role in increasing the number of HIV infection in rag pickers (Ananth et al., 2010). In 2010, 33 800 new HIV infections, 1.7 million hepatitis B infections and 315 000 hepatitis C cases of infections hadbeen reported across the world (WHO, 2013). In spite of this, the hospitals pay least attention for the proper disposal of their waste. According to practitioners, the cause of paying limited attention is the realisation of its investments into costs.The US agency, OSTP (2014) revealed that despite the heavy generation of CO_2 and harmful emissions, i.e. 380 kg and 80 kg carbon equivalents per patient per day, respectively, the investment of government in healthcare waste disposal activities is extremely low.

Ithas been observed from the literature that the healthcare waste management, in developing countries, has been paid very limited attention in comparison to other wastes such as municipal

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solid waste, e-waste, etc. (Adedigba et al., 2010; Coker et al., 2009). In India, the healthcare waste management rules had been introduced by Ministry of Environment and Forest (MoEF), first time, in 1998 and revised in 2011 and 2015, respectively. However, in spite of the strict rules and regulations of environmental bodies a remarkable improvement from the perspective of methods of disposal and management procedure could not be traced in reality. Hence, to overcome this deficiency a complete solution for managing healthcare waste has been proposed in this study.

The remainder of the paper has been organized as follows: Section 2 provides the evidences from literature for building up a theoretical framework. The research methodology for addressing the objectives is provided in Section 3. Section 4 is sufficed with the detailing ofthis multi-criteria based decision support framework. Section 5 concludes the study with its implications on environment and key decision makersin Section 6.

Evidences from literature

The research work on healthcare waste management has its roots in the seminal work of Pruss et al. (1999). The definition of healthcare waste management was introduced and amended regularly by World Health Organization with the help of academicians, practitioners, and researchers across the world. In spite of this, there has been a continuous demand from the researchers to amend the definition according to their own region or country to better define the categories of infectious HCW and hazardous HCW and for an easier understanding of legislation (Askarian et al., 2012; Caniato et al., 2015; Ferreira and Teixeira, 2010).

In the reported literature, it has been found that studies on HCWM have been conducted to understand the composition and quantities of HCW generation (Moreira & Gunther, 2013; Patil & Shekdar, 2001), to explore the best practices for enhancing HCWM (Ananth et al., 2010; Kumar et al., 2014; Sharma and Chauhan, 2008), to select the method of treatment and disposal of HCW (Huang & Lin, 2008; Liu et al., 2014; Liu et al., 2013), and to reveal the potential of recycling and reuse in HCW (Campion et al., 2015; Lee et al., 2002).

Review of the studies conducted focusing on the composition of healthcare waste

In the reported literature, a long list of studies are available that deal with topics related to the estimation of the generation of HCW per bed, per day, per department, etc. Additionally, a large number of studies have been conducted to find the composition of healthcare waste coming from particular healthcare facility/facilities. Therefore, in this section, the reported studies have been reviewed to identify the major contribution from researchers on revealing the composition and estimation of the quantities of HCW generation.

Patil and Shekdar (2001) estimated that the HCW generation rate in India was 0.5-2 kg bed^{-1} day^{-1}. They estimated the total quantity of waste as 0.33 million tonnes of waste per year with a composition of 40-45 % general waste, 7-10 % plastics, 3-5 % glass, and 30-35 % infectious HCW. Altin et al. (2003) revealed information about the composition of HCW in four hospitals in Turkey. They found that 92 % of healthcare waste was combustible in nature; whereas, 8 % was non-combustible. They estimated the waste generation rate as 1.25-2.6 kg bed^{-1} day^{-1}. Reza Sabour et al. (2007) formulated a regression model, using the number of hospitals and active bed, to predict the generation and composition of HCW in each province of Iran. Graikos et al. (2010) conducted a study to determine the production rate and the composition of HCW in the Social Insurance Institute, Xanthi, Greece. Voudrias et al. (2012) carried out a study to estimate the composition and production rate of pharmaceutical and chemical waste in Greece. Nabizadeh et al. (2012) conducted a study to estimate the composition and production rate of HCW in Hamadan, Iran. They found that 71.15 %, 21.40 %, 7.26 %, and 0.18 % denoted the general,

infectious, chemical and pharmaceutical, and toxic waste, respectively, in the composition of dental waste. Zhang et al. (2013) investigated healthcare facilities to reveal their HCW generation quantities and composition in Gansu Province, China. They found that the quantities of generation of HCW in primary, secondary, and tertiary HCFs were 0.61, 0.59, and 0.79 kg bed^{-1} day^{-1}, respectively. Maamari et al. (2015) analyzed the generation rates and patterns of HCW collected from 57 hospitals in Lebanon. The results of the study showed that the small private hospitals (<=100 beds) and large private hospitals (=>200 beds) generated the infectious HCW as 1.14 kg bed^{-1} day^{-1} and 2.45 kg bed^{-1} day^{-1}, respectively. Moreira & Gunther (2013)assessed the HCWM plan on the basis of composition and quantities of generated HCW at primary healthcare facilities (PHFs) in Sao Polo Brazil.

Review of the studies conducted to explore best practices in healthcare waste management

In the reported literature, a large number of studies have been found that focus on the identification of best practices (drivers) for improving HCWM at different healthcare facilities. This information helps in understanding, identifying, and providing an exhaustive list of the best practices from the reported literature. Along with this, it also helps to identify related research issues based on reported best practices.

Caniato et al. (2015) reported a review of literature on HCWM considering the low, middle, and high income countries across the globe. They mentioned the best practices and key definitions for the most significant factor for better HCWM. They stated that the development of a sustainable HCWM plan and its execution with the help of best practices, such as proper segregation, regular training and awareness programs for healthcare personnel, educating patients and the public, administrative monitoring and control, implementation of legislations, etc., at the level of healthcare facility, province, and waste disposal facility, is required at the present time in developing countries. Patil and Shekdar (2001) attributed the poor management of HCW in different healthcare facilities to technological inefficiency, lack of funding, and lack of trained professionals for healthcare waste management. Askarian et al. (2004) noted that the lack of segregation between hazardous and non-hazardous waste, lack of implementation of the laws related to collection of waste from patient wards and temporary storage sites, disposal of HCW with MSW, lack of training of personnel, lack of personnel protective equipment, and insufficient knowledge of the proper use of these equipment were the significant issues existed in the healthcare facilities.

Gupta & Boojh (2006) reported the lack of segregation of infectious and non-infectious waste and a 2-3 day holding of the waste in the hospital, the lack of a treatment facility for infectious waste on hospital premises, the open dumping of the waste coming from research laboratories, and health hazards to rag-pickers due to infected syringes etc., in Balrampur hospital. Bdour et al. (2007) noticed the lack of implementation of bio-medical waste management rules that leads to the poor segregation and high quantities of HCW. Alagoz & Kocasoy (2008) noticed the lack of appropriate laws and effective control, lack of awareness, and financial constraints leading to poor management of this waste. Arab et al. (2008)reported that the lack of warning signs at temporary storage sites, poor segregation of waste, and the absence of waste treatment and disposal equipment in hospitals led to poor healthcare waste management in Tehran. Sharma & Chauhan (2008) carried out a study to assess the biomedical waste management of three large hospitals in Agra, India. They found that the lack of knowledge, lack of awareness, and old technology for disposal leads to poor HCWM.

Birpinar et al. (2009) conducted a study in the hospitals of Turkey and found a lack of appropriate waste containers, a lack of temporary waste storage sites in hospital premises, and a lack of personnel protective equipment for safe handling of HCW. Rao (2009) noted issues, such as

budget constraints, training and awareness programs for healthcare workers, lack of a waste management officer in many hospitals, irregular monitoring and control, and the lack of use of proper color-coded bags for source segregation at the micro level. Omar et al. (2012) found poor waste segregation practices, improper usage of color-coded bags, poor usage of waste containers, improper record keeping of waste generation quantities, absence of temporary waste storage sites, and lack of training and awareness programs. Longe (2012) conducted a study in 20 healthcare facilities containing 20 to 600 beds in Ikorodu and Lagos state of Nigeria. They found that the healthcare facilities have a lack of waste treatment systems, lack of funds, and lack of professionally trained waste management officers.

Shiferaw et al. (2012) carried out a study to understand the causes of diseases occurring from sharps, blood, and bloodied body fluids to healthcare personnel. They found that less than 50 % of workers wore gloves or boots, workers lacked knowledge of HIV and hepatitis B, and that a lack of personnel protective equipment led to the diseases. Kumari et al. (2013) discussed a report of the Civic Action Group (CAG), which pointed to the lack of awareness and lack of commitment of senior officials at the hospital and government level leading to poor HCWM in hospitals. Therefore, it has been argued by the researchers that there is an urgent need for a HCWM plan that could include the sound arrangement of a healthcare facility, using appropriate technology, operational plans, financial management, and timely training programs for staff, highlighting the importance of risk management within and outside of a hospital, the health and safety of healthcare workers, training programs, and an emphasis on segregation for recycling and better disposal of HCW.

Mostafa et al. (2009) carried out a study assessing the knowledge and awareness of doctors, nurses, ward boys, and housekeeping staff at Al-Mansoura University Hospital, Egypt. They revealed that the healthcare personnel, including doctors and housekeeping staff, did not have an adequate knowledge and awareness about HCW. However, the results showed that training of nurses was positively related to the knowledge they carry about HCW. On the basis of the findings, they formulated and implemented protocols to enhance HCWM. Al-Khatib & Sato (2009) conducted a study to assess the implemented HCWM practices in the Palestinian Territory. They found that the practices were not implemented properly according to WHO standards; therefore, the policies, along with a comprehensive plan, should be implemented to provide a technologically sound and environmentally sustainable HCWM plan. Khammaneechan et al. (2011) conducted a study to assess the implementation of practices related to HCWM. Lakbala & Lakbala (2013) carried out a study to assess the knowledge and attitude of healthcare workers towards HCWM in Shiraz, Iran. Gavrancic et al. (2012) conducted a study to assess the implementation of a national strategy for HCWM at the Oncology Institute, Serbia. They evaluated the collection, segregation, storage, handling, transportation, and disposal of HCWs at this healthcare facility.

Ratkovic et al. (2012) assessed the efficiency of 35 healthcare facilities on the basis of technology implementation in the collection and disposal of HCW using a data envelopment analysis method in Serbia. They found that 60 % (21) of the healthcare facilities were inefficient with an average level of inefficiency of 13 %. They stated that the findings of the study could be useful in providing insights for better planning and management of HCW. Chaerul et al. (2008) studied the interaction among the factors of HCWM using a system dynamics approach. They concluded that the implementation of an effective segregation plan would help in minimizing the risk as well as harmful emissions associated with the handling and disposal of this waste. Ali et al. (2016) conducted a study identifying the motivating factors for HCWM in developing countries. The indicators including cleanliness, implementation of legislation, training and awareness programs, and availability of funds etc., for a healthcare facility were clubbed to

form three motivating factors, i.e., reputation, liability, and expenses. They concluded that the concerns of the healthcare facilities vary considerably for liability and financial burden from one facility to another; however, it did not deflect much for the reputation of a healthcare facility in the implementation of a sound HCWM plan. Furthermore, they recommended analyzing the social, economic, environmental, and organizational factors using multi-criteria decision making methods. Moreira & Gunther (2013) argued proposing a method for evaluation of a HCWM plan including quantitative and qualitative parameters for better monitoring. These parameters could be legislation, training and awareness programs, inspection of safety equipment provided to workers, and reduction in the volume of waste reaching sanitary landfilling sites with the help of enhanced segregation of waste. Lee et al. (2002) studied the potential of recycling the plastic waste generated in hospitals. The advancement of technology, such as the development of chlorine free blood bags as an alternative to PVC, diminishes the harmful emissions associated with incineration of waste (Altin et al., 2003; Ratkovic et al., 2012).

Review of the studies conducted on disposal of healthcare waste

The disposal of HCW has been considered an important issue to be researched due to its social and environmental implications. In the reported studies, most of the research work has been conducted for estimating harmful emissions and poisonous gasses generated from burning of this waste. This section reviews the reported studies for disposal related issues and paves the way for management research of HCW.

Alvim-Ferraz & Afonso (2005) carried out a study for assessing the percentage of harmful emissions which occurs in the disposal of HCW. They found that the incineration of this results into the 80 % harmful emissions which could be curbed with the help of an effective segregation and disposal strategy of HCWM. Mbongwe et al. (2008) explored the need of an organized HCWM system so that the risk associated with the generation of harmful emissions in incineration could be computed and compiled. Cheng et al. (2009) stated that heavy quantities of infectious HCW were incinerated in hospitals that led to the production of large quantities of harmful emissions. Liu et al. (2013) stated that the incineration, steam sterilization, microwaving, and landfilling could be the methods of disposal for HCW at a central waste disposal facility. The selection of a method of disposal depends on economic, social, and environmental factors (Dursun et al., 2011; Liu et al., 2014). Aghapour et al. (2013) recommended providing training and awareness programs for conducting the correct biological tests for the HCW for sterilizing and appropriate autoclaving of the infectious and hazardous HCW.

Bdour et al. (2007) studied the procedures, techniques, and methods of handling and disposal of HCW along with the qualitative and quantitative properties of HCW to assess the weight and physical properties, respectively. They noticed the lack of implementation of bio-medical waste management rules that leads to the poor segregation and high quantities of generation of HCW. Therefore, they recommended the urgent need to address the issues related to collection, segregation, handling, storage, and disposal of HCW. Coker et al. (2009) stated that the formulation of policies and implementation of legislation regarding collection, segregation, handling, transportation, and disposal for safe management of HCW is needed in a country. Additionally, they suggested conducting regular training programs for safe handling of this waste. Ratkovic et al. (2012) assessed the efficiency of 35 healthcare facilities on the basis of technology implementation in the collection and disposal of HCW using the data envelopment analysis method in Serbia. Gavrancic et al. (2012) evaluated the collection, segregation, storage, handling, transportation, and disposal of this healthcare facility. Sartaj and Arabgol (2014) carried out a study for the assessment of HCWM practices, such as collection, segregation, handling, storage, transportation, treatment, and disposal in Isfahan Province (Iran).

Bella et al. (2012) concluded that onsite incineration is an effective solution for the developing countries, such as Somaliland. Lee et al. (2004) stated that the combination of onsite incineration with microwave technologies for the treatment and disposal was the most sustainable approach in terms of economic and environmental sustainability. However, Taghipour et al. (2014) assessed and compared onsite treatment and disposal with offsite treatment and disposal of HCW. They noted that onsite treatment and disposal of HCW lack plans, finances, the determination of the capacity of the installations, proper operations, and maintenance. Therefore, they suggested the centralized offsite treatment and disposal of HCW. Karagiannidis et al. (2010) argued that a central HCW treatment and disposal firm assists the hospitals in reducing the environmental impact and cost of disposal of HCW.

Nema et al. (2011) highlighted the importance of private players, such as common HCW disposal firms or outsourcing firms. Therefore, it was suggested that hospitals use services from these centralized HCWM treatment and disposal firms for safe disposal of this waste (Abdulla et al., 2008; Bendjoudi et al., 2009; Verma et al., 2008). Graikos et al. (2010) suggested the disposal of infectious HCW with the help of an outsourcing firm for safe and cost-effective disposal. Ho (2011) conducted a study for the selection of an appropriateHCW disposal firm for the hospitals of Taiwan using fuzzy analytic hierarchy process. Hsu et al. (2008) addressed the problem of selection of a HCW disposal firm for the hospitals of Taiwan. They recommended that the selection of a sustainable HCW disposal firm by a hospital depends on the contractor's qualification, contractor's service capability, contractor's equipment, etc. Liu et al. (2014) conducted a study for the selection a HCW treatment and disposal technology using a multi-criteria method (interval 2-tuple MULTIMOORA). They recommended dealing with the issue of HCW disposal/ outsourcing firm selection using multiple criteria.

Ciplak & Barton (2012) carried out a study for selecting and planning the treatment capacity of a HCW disposal firm with the help of a system dynamics approach. They recommended the application of multi-criteria decision making methods for selecting an appropriate HCW disposal firm. They also suggested the consideration of environmental, social, and economic criteria for the waste disposal firm's facility location. Ruoyan et al. (2010) pointed out that a sufficient budget and attentive administrative monitoring is required for the establishment and function of an offsite common HCW treatment and disposal facility. The future capacity planning of a disposal firm for the disposal of HCW was another major issue highlighted by authors.

The studies reveal that healthcare facilities produce a high content of waste materials that could be recycled with the help of competent technology and infrastructure (Altin et al., 2003; Coker et al., 2009; Jang et al., 2006; Lee et al., 2002; Sawalem et al., 2009). Additionally, some researchers criticized the process of waste disposal through incineration, dumping, or landfilling (Adedigba et al., 2010; Alvim-Ferraz and Afonso, 2005; Nemathaga et al., 2008; Tamplin et al., 2005). Some researchers emphasized the benefits of HCW recycling that could outweigh the other treatment and disposal methods (Bdour et al., 2007; Campion et al., 2015; Jang et al., 2006). HCW recycling is a more sustainable approach because it adds weight and covers the shortfall and weaknesses of other disposal methods.

Countries like India and China account for almost 38 % of the world's population and generate a large amount of waste: therefore, there is a need for research in HCWM in these countries. Although we have found many HCWM studies from these countries, most of them focus on the computational aspects of generated waste and its composition. Many of them have suggested improving segregation practices by waste separation at the source, leading to minimum waste for incineration and landfilling, thereby increasing the scope of recycling. Although past studies highlighted the seriousness of the issue in the future, a study of the development of a

comprehensive and sustainable plan for HCWM to deal with the large quantities of HCW in these countries is missing in the literature. Therefore, it can be concluded from our review of literature that there is an evident need for better HCW disposal alternatives, such as recycling, in order to address issues with the environment, human health, and resource conservation.

Based on the review of literature in the above mentioned three sections, it can be stated that the previous studies have attempted to work upon a specific issue in spite of providing a complete managerial solution model to hospitals and waste disposal firms. Majorly, the work included the understanding of waste generation rates, assessing the impact of training and awareness programs on healthcare waste management, the disposal of healthcare waste and impact of toxic emissions on environment. Few behavioural studies such as establishing the relationship between attitude of a healthcare worker and quantity of waste generated. However, the studies such as identifying and analysing the drivers for effectively managing healthcare waste at hospitals, comparatively assessing the waste management of different hospitals, selection of healthcare waste disposal (outsourcing) firms, the identification of an appropriate location for establishing a plant for waste disposal, the capacity planning of a healthcare waste disposal plant, the optimization of resources in collecting healthcare waste from hospitals for disposal at plant, and the plant layout design has not been paid adequate attention in the literature.

Research Gap & Research Problem

In the nut-shell it can be stated that the development of this multi-criteria decision support framework would help in addressing the following issues/gaps:

- To identify and model the drivers of HCMW to understand their inter-relationships.
- To evaluate the selected drivers and develop a comparative assessment model on the basis of these drivers.
- To assist the hospitals in selecting an appropriate HCW disposal firm with the help of a hybrid model.
- To assist the HCW disposal firms in the selection of healthcare waste disposal facility locations.
- To develop a forecasting model of HCW generation for assisting HCW disposal firm in its capacity planning.
- To formulate a reverse logistics model for optimizing the resources used for collecting the healthcare waste from hospitals.

Hence, to address this void in the literature, the development of a theoretical decision support framework would assist the key decision makers in making effective decisions for enhancing healthcare waste management in developing countries.

Research Methodology

The objectives highlighted in the previous section can be handled effectively using multi-criteria decision making methods such as interpretive structural modelling method (ISM), decision making trial and evaluation laboratory method (DEMATEL), analytic hierarchy process method (AHP), analytic network process method (ANP), technique for order preference by similarity to ideal solution method (TOPSIS). The optimization models such as integer linear programming, deterministic, dynamic, stochastic, and goal programming can be used for reverse logistics model development for waste collection. The statistical methods such as regression and ARIMA modelling help in understanding the co-relation and advance planning of healthcare waste disposal.

Proposed multi-criteriadecision support framework for HCWM

Healthcare waste management of a country highly depend upon the positive participation of key decision makers towards this issue. The key decision makers include the hospital for managing the waste within its premises and the healthcare waste disposal firms which collect and dispose the waste at a safe place.In hospitals, the key participants of waste management team consist of a waste management officer, medical superintendent, head nurse and other members. The waste management team has the responsibility to continuously monitor the management of waste with the given economic and environmental constraints. The decisions within the premises of hospital are most likely related to the hygiene, segregation, handling, and temporary storage of waste. Hence, to assist the hospitals in decision making there are four key decision points, i.e. D1, D2, D3, and D4, have been mentioned in the developed theoretical decision support framework i.e. Figure 1. Similarly, the four key decision making points for healthcare waste disposal firms, i.e. D5, D6, D7, and D8, which include the selection of a location for establishing a waste disposal plant, network design for waste collection,its capacity planning, and process selection for disposal, have been mentioned in Figure 1.

In practice, the eight vital decisions which have been highlighted in Figure 1are most likely taken in dynamic multi-criteria scenario of decision making. The decisions D1, D2, D4, D5, and D7 are completely taken based on multi-criteria focused analytical modelling. The Decisions D3, D6, and D8 would be best achieved using the hybrid of statistical, multi-criteria, and mathematical modelling.

Apart from hospitals and healthcare waste disposal firms, the third party which is responsible for the management of healthcare waste is pollution control board. The pollution control board monitors the situation of waste management in hospitals on the basis of the guidelines provided by government.As discussed, the ministry of environment and forest in India formulates the rules and policies related to healthcare waste management. The pollution control board of India helps in implementing the policies for better healthcare waste management.The decision support framework developed in this study vividly helps the ministry and pollution control board for making and implementing policies in a more effective manner. The comparative assessment model developed for taking decision D2 would immensely help the pollution control board in overcoming its manpower deficiency problem and correct assessment of waste disposal of hospitals. Similarly, the model developed for taking decision D5, i.e. the selection of an appropriate healthcare waste disposal plant location, would help the ministry in formulating the policy related to location requirements for establishing a waste disposal plant.

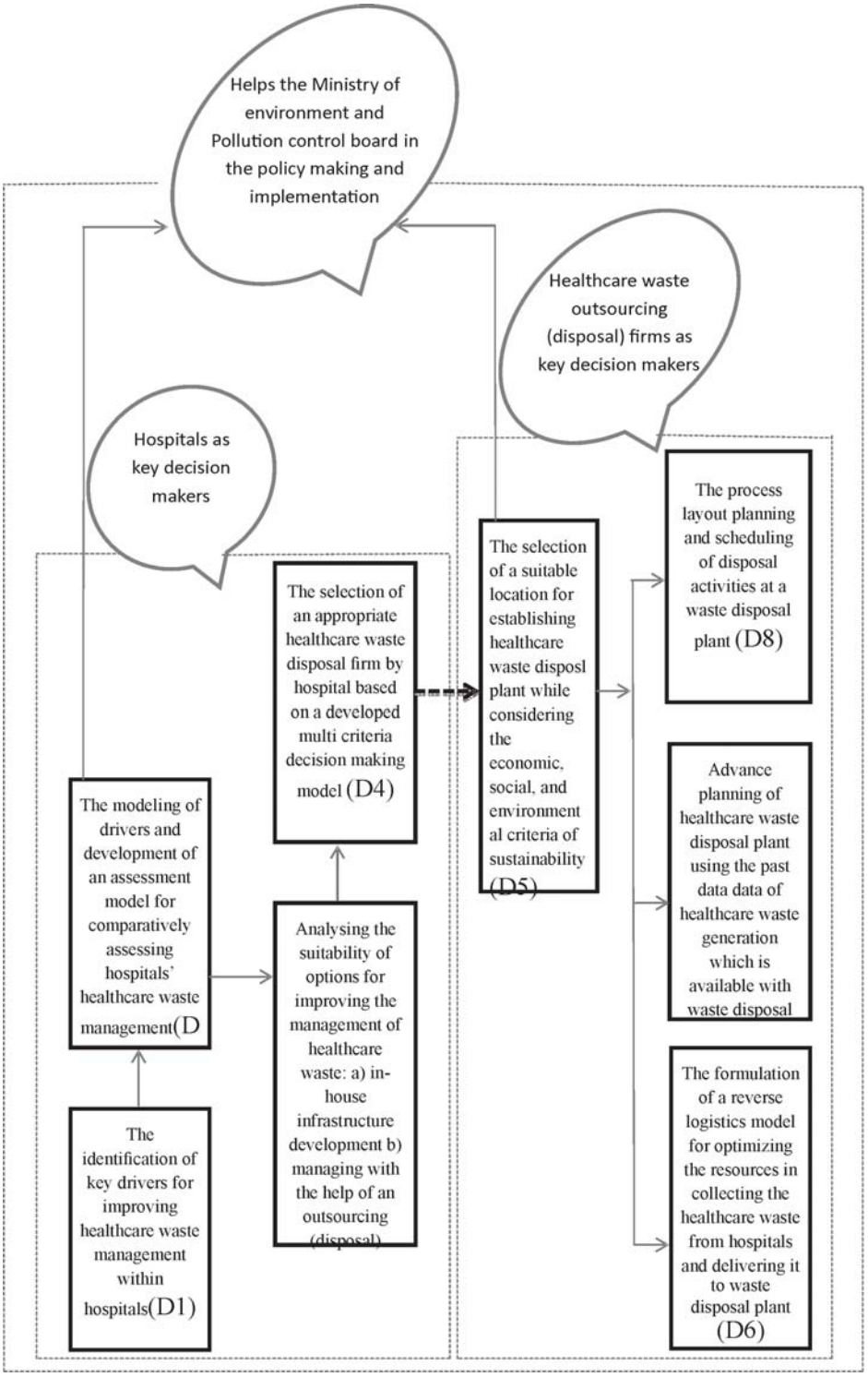

Figure 1: A theoretical decision support framework for addressing healthcare waste management issues in developing countries

Conclusion

The proposed decision support framework which is based on multiple criteria provides a line of action for hospitals and healthcare waste disposal firms for the effective management of healthcare waste in an economically, environmentally, and socially sustainable manner in developing countries. Since, the eight key decision points which have been highlighted in Figure 1 are majorly based on multiple criteria; therefore, the implementation of the above proposed framework would be very effective and sustainable for decision makers. With the help of the proposed framework, the key decision makers would be benefited in terms of saving on financial resources and time, overcoming manpower inadequacy, creating positive word of mouth, and improved social acceptability.The implementation of the proposed framework by hospitals and waste disposal firms could be proved as a self-acting algorithm in diminishing the complaints of public regarding environmental issues generated from the activities related to healthcare waste disposal. The increased level of public satisfaction, especially in terms of environmental matters, inevitably shows a win-win situation for public as well as administration.

Implications of the Study

The research objectives identified and discussed for addressal with the help of different multi-criteria, optimization, and statistical modelling would be very beneficial from the perspective of society, environmental bodies, hospitals, and other stakeholders. The proposed decision support framework is a complete solution for the typical issue of healthcare waste management in India. On one side this decision support framework is complete and capable in terms of protecting the environment and society; whereas, on the other side it shows the path for the development of a successful business model from this type of neglected & loss making businesses. With this, not only the hospitals and healthcare waste disposal firms business strategies would become profitable but also their operations would become proficient and lucrative to attract positive public attention.

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